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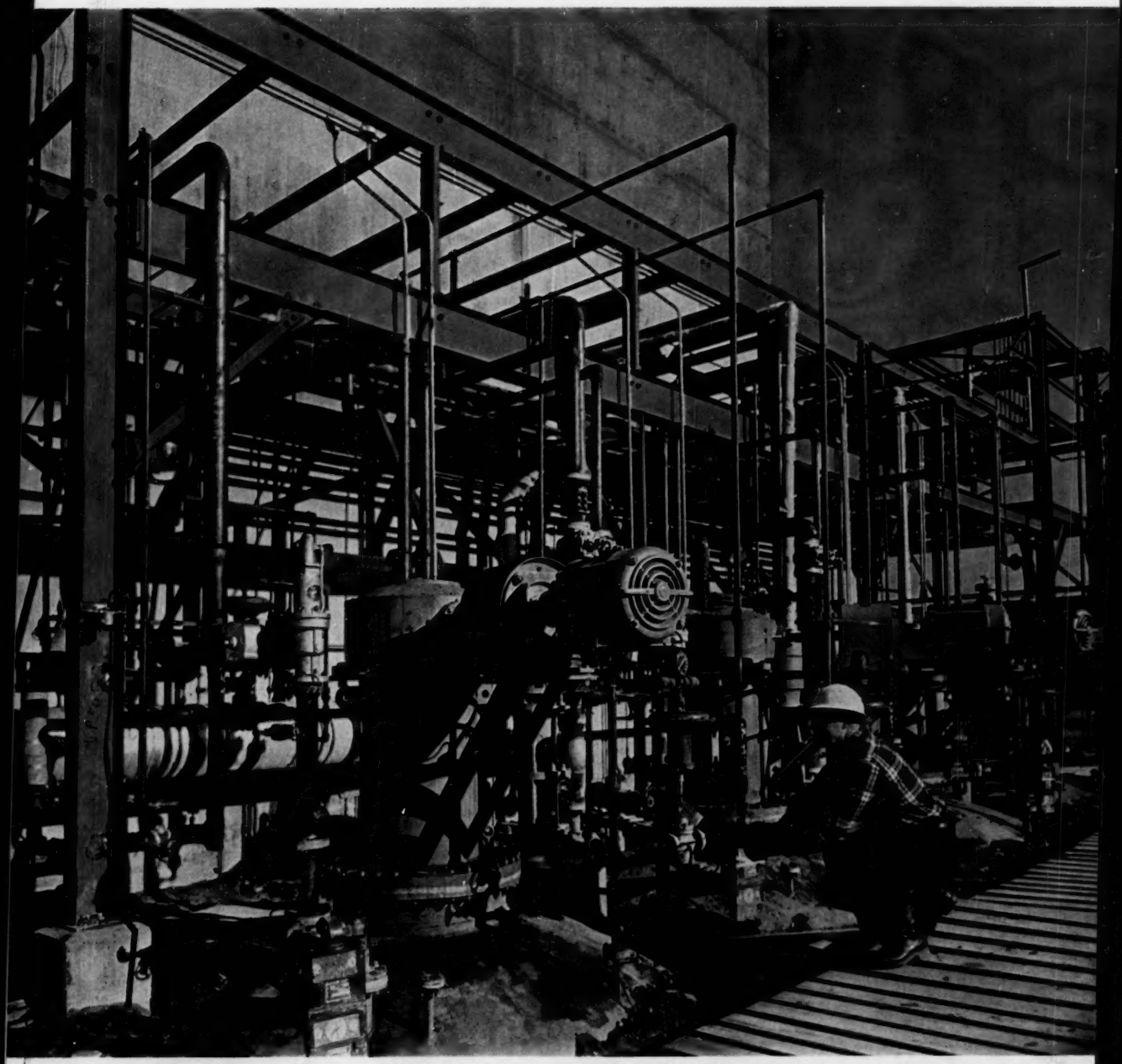
Chemical Engineering

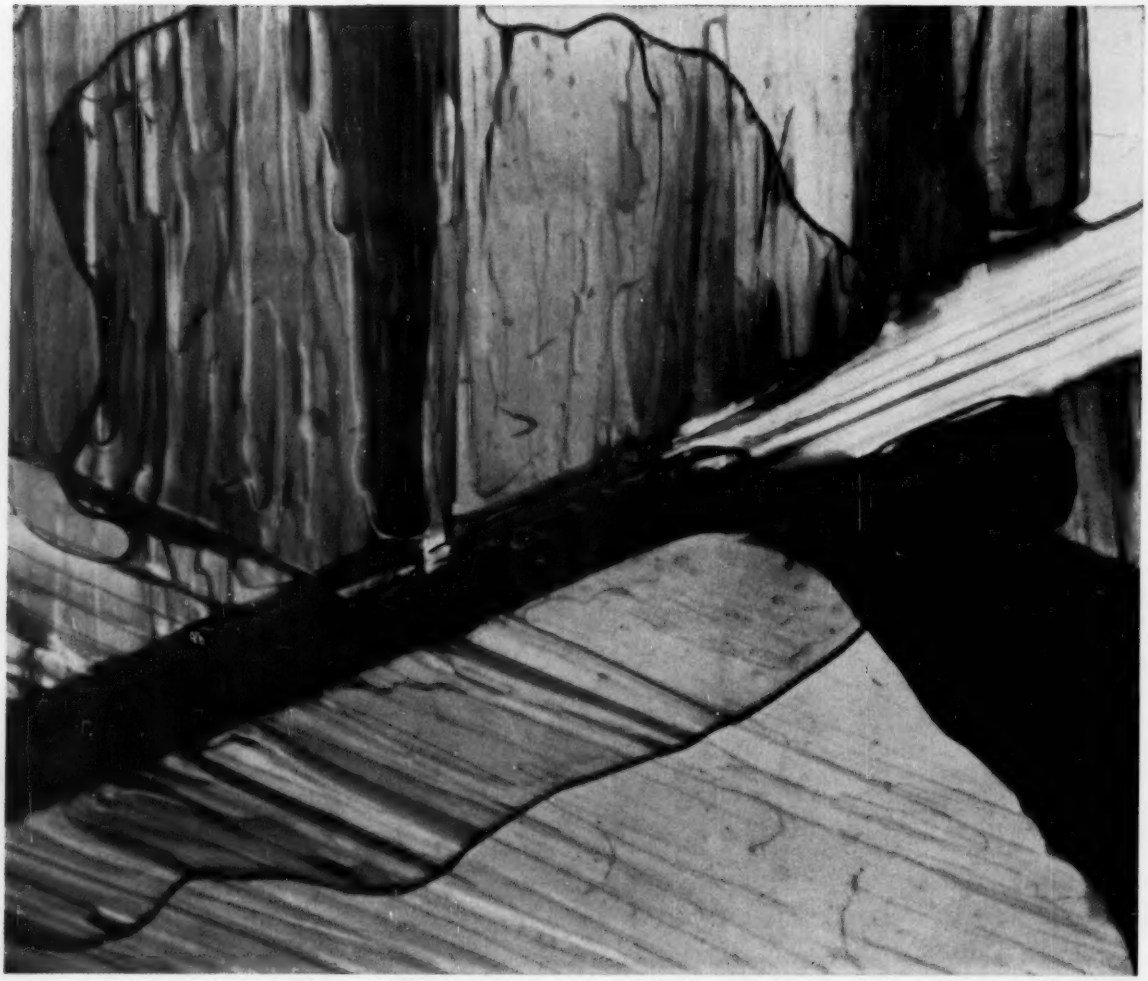
A McGRAW-HILL PUBLICATION



Advance planning and good organization can smooth the way to successful plant startup—p. 107

New idea for reinforcing jacketed vessels improves heat transfer and lowers cost—p. 127

Safer handling of acetylene promised by guide to recommended distribution practices—p. 131



The Shell chemicals listed below are sources for many important commercial products.

Familiar landscape?

The inquiring chemist explores many interesting product "landscapes" in his work. This photomicrograph shows crystals of *tertiary butyl alcohol* at 65°F. TBA, a Shell chemical with intriguing features, finds its way into a variety of industries.

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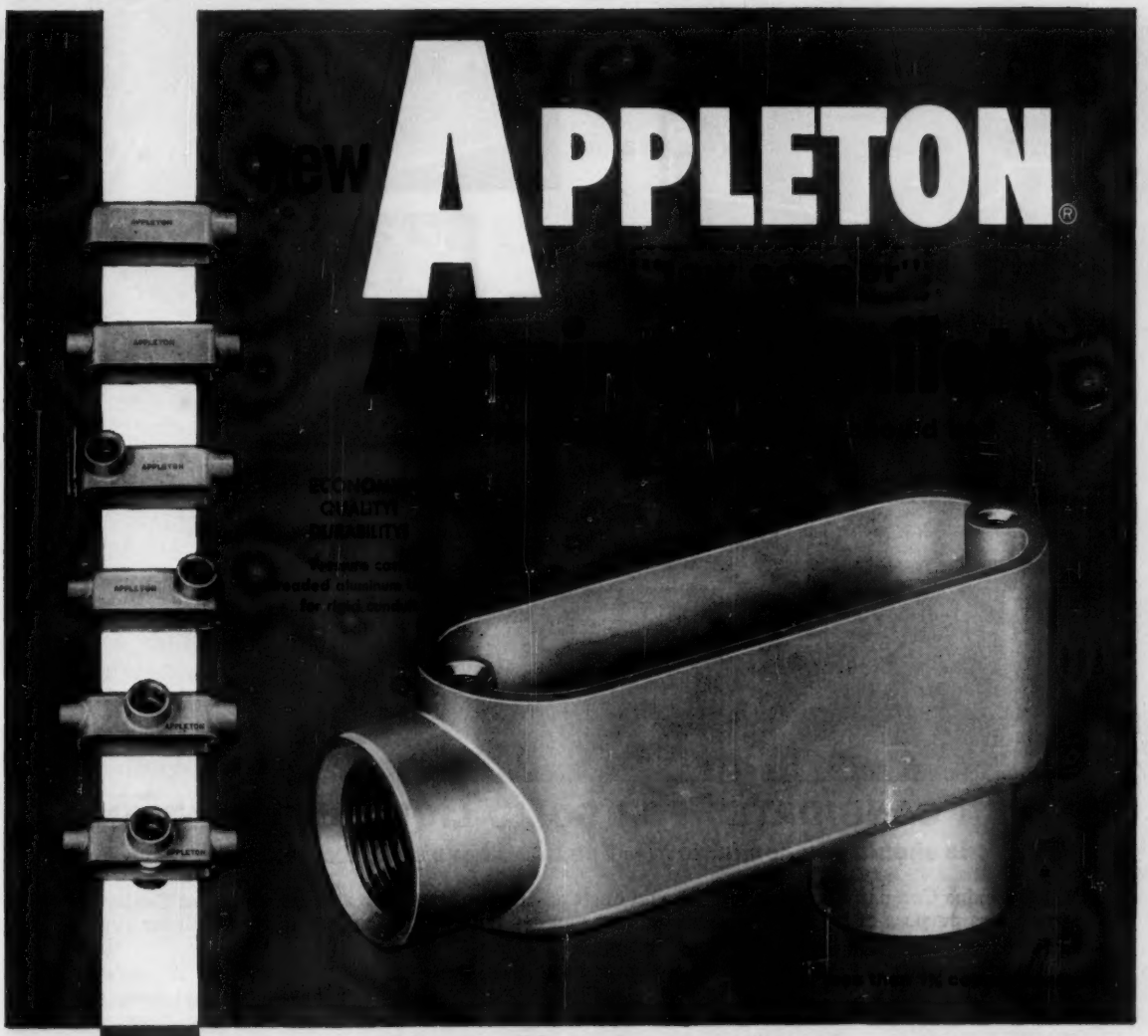

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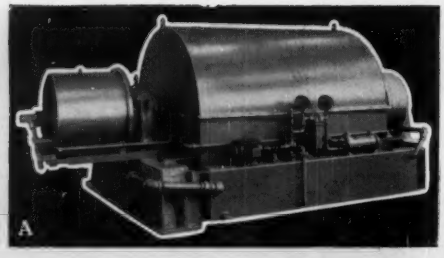

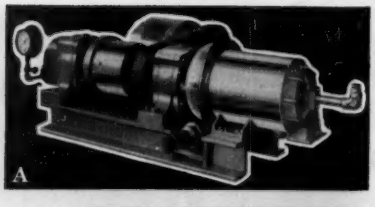

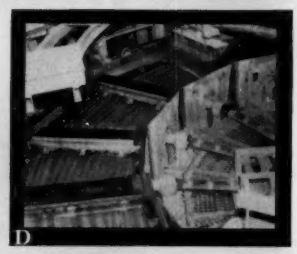

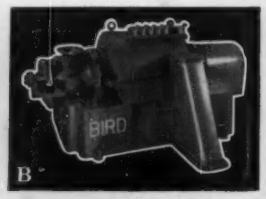

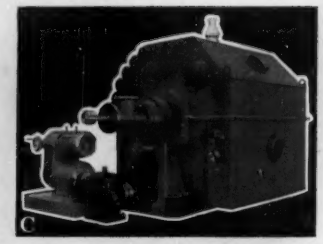

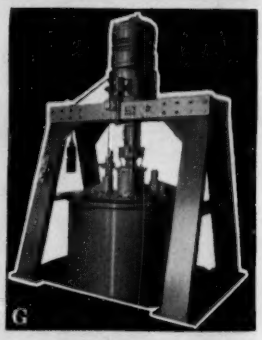

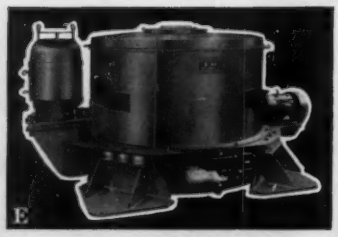

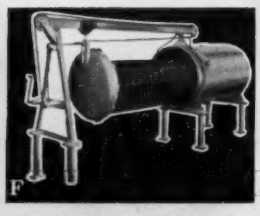

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(E) Bird-Humboldt Oscillating Screen Centrifuges dewater plus 65 mesh solids with almost no degradation or loss of solids. Output up to 80 tons or more per hour. Screens last thousands of hours. Power cost is only 0.2 KWA per ton of dried solids.

(F) Bird Pressure Leaf Filters offer large filter area, high rate of flow, working pressures up to 75 psi standard (250 psi special). Sturdily constructed of corrosion resistant alloys or with special linings; insulated; steam jacketed; in a wide range of sizes.

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September 5, 1960

Chemical Engineering

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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highlights of this issue

HOW TO PREPARE FOR PLANT STARTUPS

Starting up a new chemical process unit is a lot like having a baby; you can't eliminate all pain and danger, but you can minimize the risk by adequate advance preparation. Feature Report in this issue comprises 20 pages of advice to expectant process and project engineers. Author J. E. Troyan has attended the birth of many a process unit as an engineer-manager with Olin Mathieson. This article draws from his own rich experience, as well as that of many others.

Those of you who are involved right now in planning a new unit will want to turn to p. 107 immediately. The rest of you may wish to begin as usual with *Chementator*, but be sure to budget reading time and filing space for this intensely practical *CE* feature.

CRYOGENICS MOVES IN ON METHANE

Recent advances in low-temperature technology have given fractional distillation an edge in that eternal unit operations triangle: distillation-absorption-adsorption. By distilling natural gas at —205 F., Allied Chemical gets a stream of process methane having less than 100 ppm. impurities—way beyond purity levels commercially attainable via ab- and adsorption. Allied's Moundsville, W. Va., installation, engineered by Air Products, is described in our Process Flowsheet (p. 98).

REVIEW MASS TRANSFER CONCEPTS

L.S.U. Profs. Coates and Pressburg resume their *CE* Refresher series on unit operations, having enjoyed a respite while Profs. Akers and Davis of Rice Institute were holding forth on unsteady-state heat transfer.

Leading off (p. 135) is the first of a series on mass transfer —foundation of such operations as absorption, stripping, extraction, leaching and drying. Among the entire engineering profession, the chemical engineer is uniquely qualified to practice in the field of mass transfer. Don't miss this chance to update your knowledge and skills in this field.

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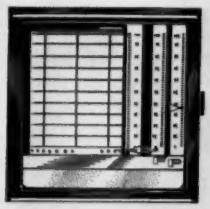

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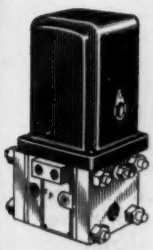

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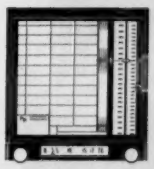
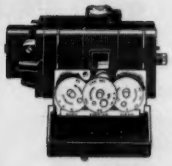
53P CONTROLLER
MINIATURE INSTRUMENTS
TEMPERATURE AND PRESSURE
BELLOWS METER





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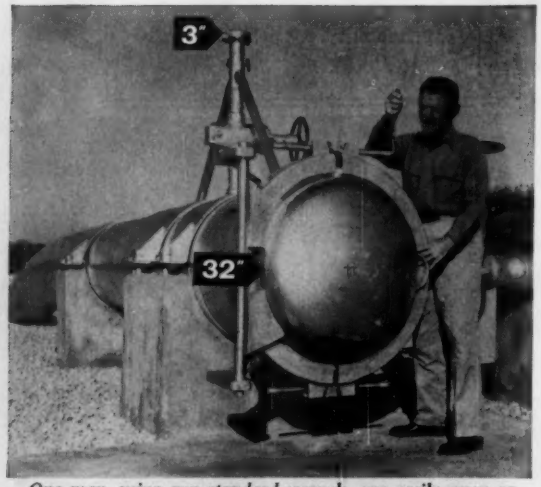

One man, using any standard wrench, can easily open or close the TUBE-TURN *Hinged Closure. Has important safety features, too!*

For vertical applications, TUBE-TURN *Hinged Closures can be equipped with spring-loaded, counterbalanced caps.*

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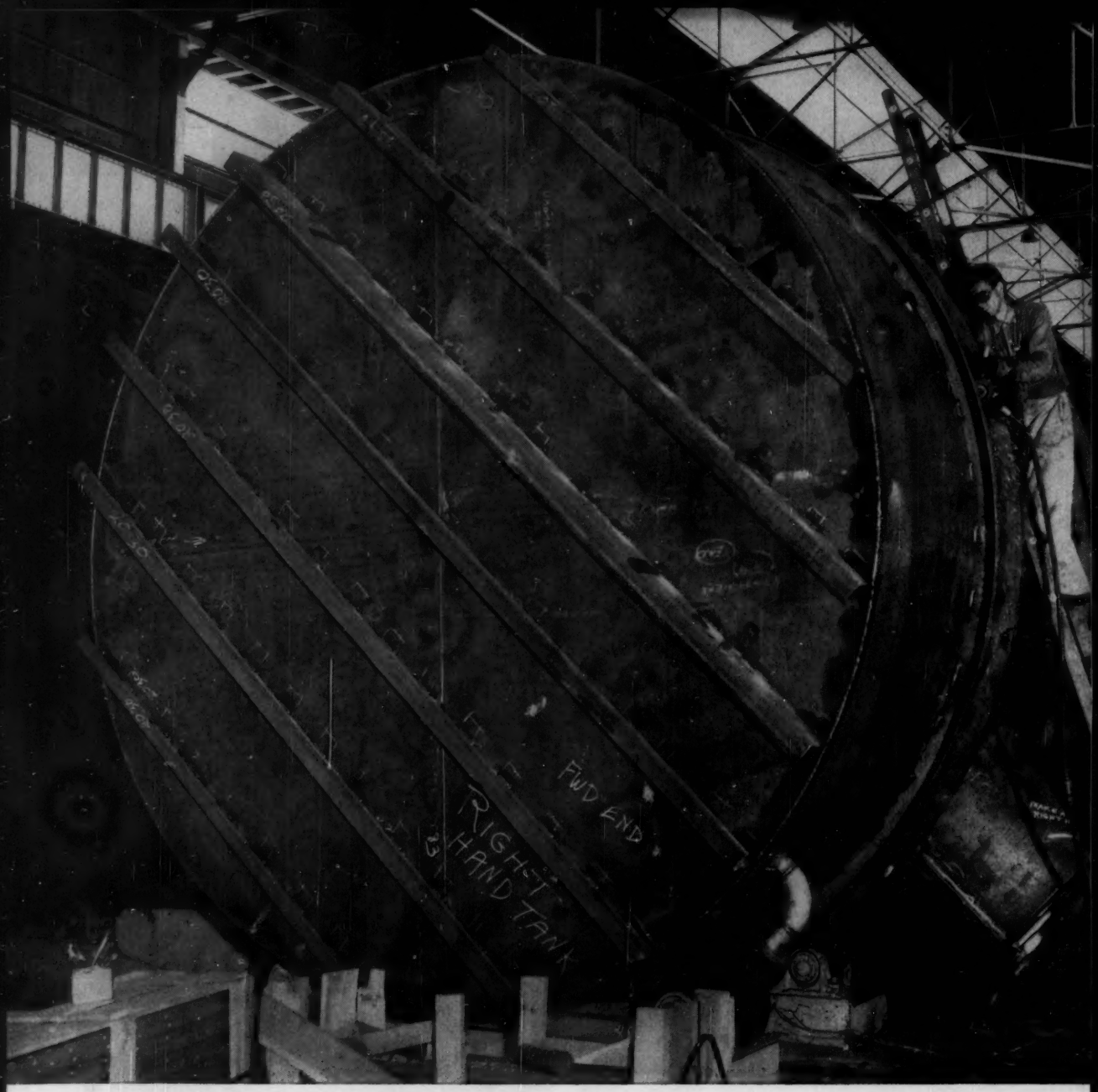
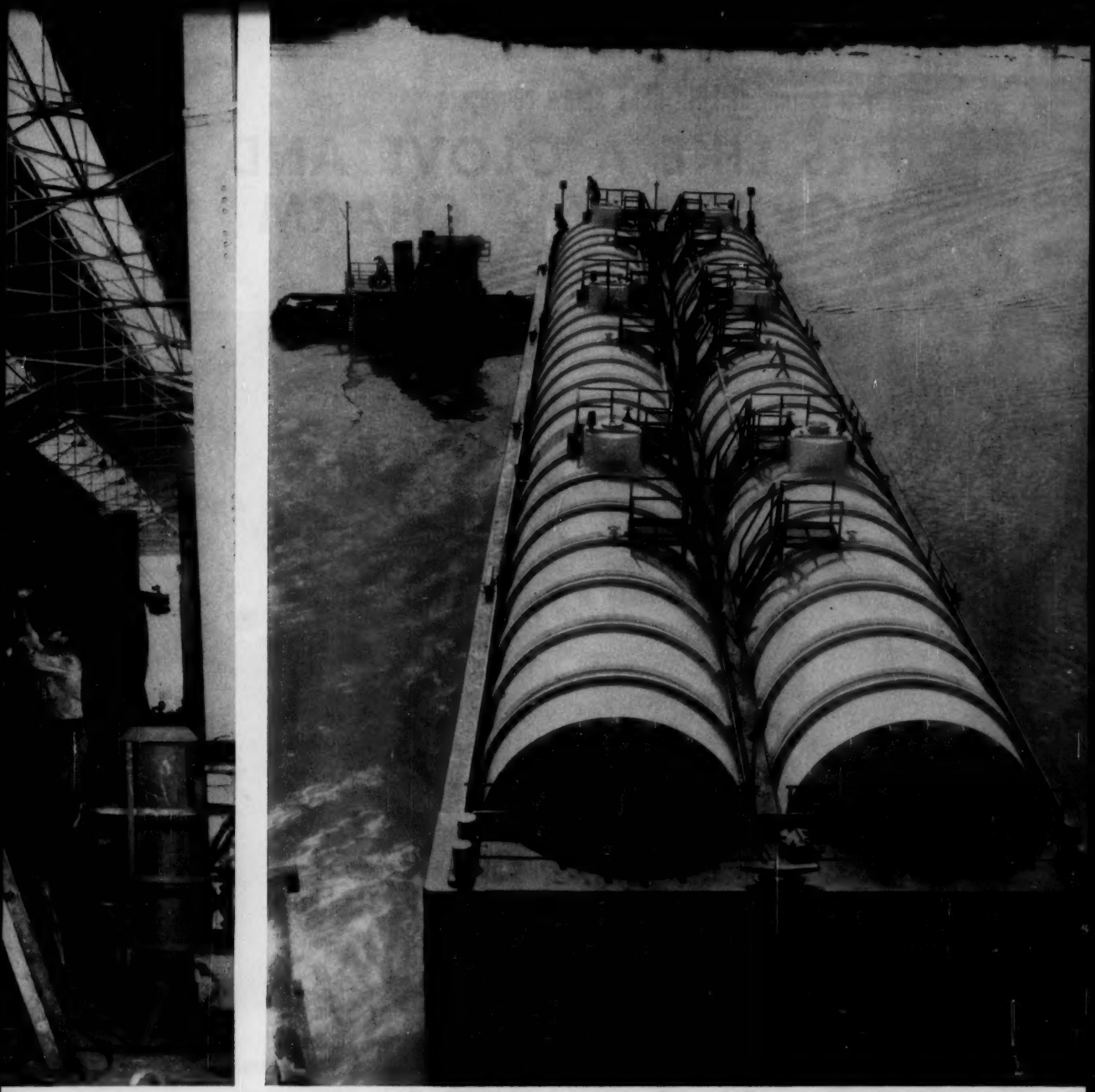


Tanks as big as a barge can carry

These new tanks have unobstructed interiors to carry maximum cargo with least danger of contamination—the essential requirements of an order for two independent tank barges from Union Carbide Chemicals Company. One barge is designed to carry Grade A and lower liquids having a Reid Vapor Pressure not exceeding 25 psi. The other barge will carry similar cargoes having a Reid Vapor Pressure not exceeding 40 psi. ☐ American Bridge designed and constructed the tanks and barges at its modern Plate Shop in Orange, Texas. The results: two Jumbo Hopper Barges 195′ x 35′ containing six tanks 52′ long x 14′-6″ O.D. and weighing 22 tons with a total



capacity of 383,000 gals. per barge. The reinforcing members for the tanks were placed on the tank exteriors leaving unobstructed nickel-plated interiors. ☐ Whatever your plate needs, we have the staff and facilities to take care of them, and our strategic location permits shipment by train, truck or barge. Write for our booklet completely describing plate fabricating and construction services.

USS is a registered trademark

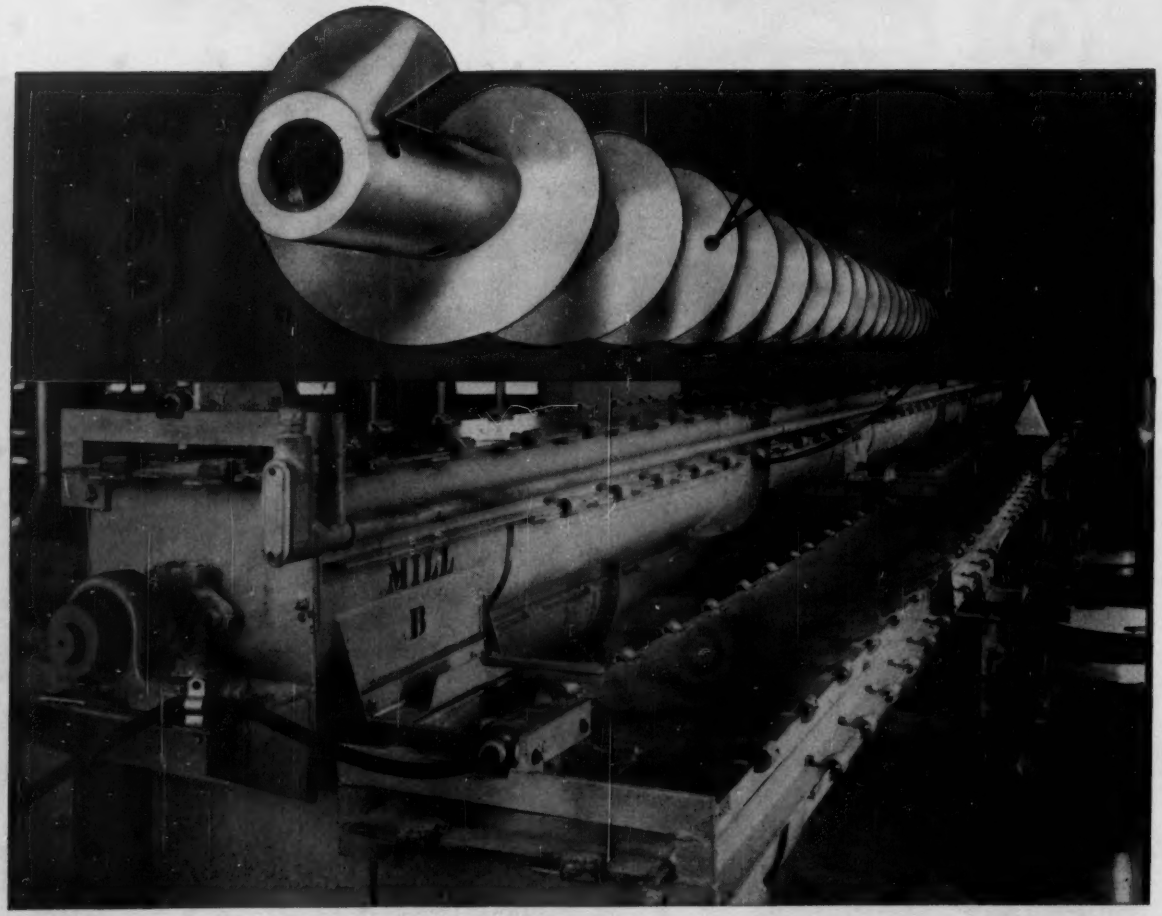
General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Harrisburg, Pa. • Houston • Los Angeles Memphis • Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh • Portland, Ore. Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York

American Bridge Division of United States Steel

USS

Why a system of LINK-BELT screw conveyors

FITS LIKE A GLOVE AND WORKS LIKE A CHARM



- **Thorough engineering analysis of all conditions**
- **Full responsibility for satisfactory performance**
- **Unbiased selection from industry's most complete range of components**
- **Expert field erection**

With Link-Belt, screw conveyor engineering includes far more than just supplying a suitable product. All related aspects of your production are considered—including prior and subsequent handling, plus integration with other equipment. And because Link-Belt handles all details from specification to erection, it means a better-working system with less work for you.

Continuous product improvement and development by Link-Belt has produced industry's widest range of components for screw conveyor applications—various types of flighting, gates, troughs, drives . . . plus a new line of ball and roller bearing equipped accessories.

Link-Belt specialists will work with you to determine the feasibility of adapting screw conveyors to your operation. Call or write your nearest Link-Belt office for full details. Ask for Book 2989.

LINK-BELT

SCREW CONVEYORS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,234

HACKNEY
SEAMLESS
CYLINDERS

...a sound investment

Here are your dependable shipping containers for chlorine, hydrogen chloride, boron trifluoride, nitrous oxide, carbon dioxide, oxygen, nitrogen, hydrogen, helium, argon and many other compressed gases. Remember, Hackney quality costs no more—assures long life; low upkeep; safe, convenient shipping and dispensing. Compare these outstanding Hackney advantages—then write for details:

—Smooth, cold drawn surfaces clean easily, paint quickly.
—Modern appearance for industrial and medical applications.
—Controlled tare weights through deep drawing process.
—Your name neatly embossed on neck ring.
—Clear, easy-to-read stamping eliminates errors.
—Uniform capacity simplifies filling and record-keeping.
—Complete range of sizes and shapes to meet requirements of all industries.
—Central shipping location means faster service, with favorable freight charges.

Hackney

Pressed Steel Tank Company

Manufacturer of Hackney Products

1447 S. 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

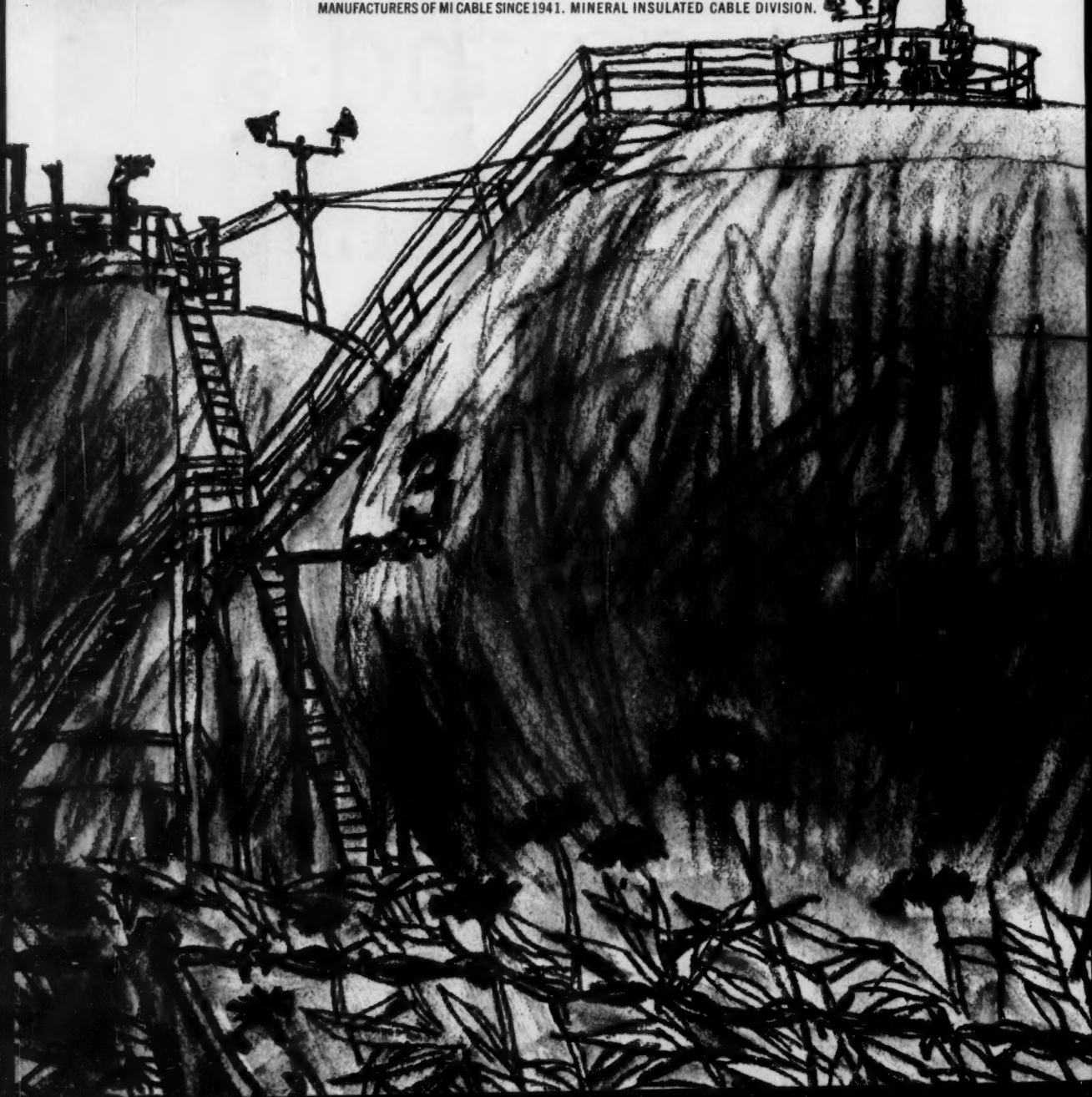
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

MI FOR MAXIMUM SAFETY AND SERVICE IN HAZARDOUS AREAS

Where the presence of gases, dusts, ignitible fibers, solvents or water increase safety problems and the mechanical failure of ordinary wiring devices, a Mineral Insulated wiring system gives maximum protection with no loss of efficiency. Built-in features, not found in any other wiring system, make MI ideally suited for all types of "trouble areas." MI installations have proved themselves in such diversified industries as drugs, chemicals, textiles and petroleum refining . . . see how MI can improve your process equipment. A brochure will gladly be sent upon request. General Cable Corporation, 730 Third Ave., N. Y. 17, N.Y.

GCC
GENERAL CABLE CORPORATION

MANUFACTURERS OF MI CABLE SINCE 1941. MINERAL INSULATED CABLE DIVISION.



PRIVATE PROPERTY
KEEP OFF
DANGER
PUBLIC SERVICE

De Laval tackles process problems

...economically!

Hic!

Many barrels of wine have barreled through our sturdy Plate Heat Exchangers. So, too, have vast quantities of orange juice, milk and beer. Between the stainless steel plates, pasteurization temperatures are quickly reached and closely held. Remarkably high exchange efficiencies are economically evident in heating, cooling and regenerative sections. High turbulence, even at low velocities, is assured by the corrugated plates of De Laval Plate Heat Exchangers. Differentials as low as 5°F in the exchange streams are practical.

Food applications have been a "natural" for the sanitary construction of these exchangers. But their performance efficiency and maintenance economy is earning more spots in rough industrial service. The reasons are simple and sound:

- Sturdy stainless steel gives the insurance of long, dependable, maintenance-free operation.
- Capacity is easily increased any time. Just add plates.
- Arrange for dual or triple-section operation by simply adding headers.
- Clean-in-place, as required; or open in minutes for full exposure of plate surfaces.
- Typical heat transfer coefficients are in the range of 600-750 Btu/hr-ft²-°F — often over 900!
- Full capacity range—to 1600 square feet of exchange area.
- The most compact heat exchange system available. Stands freely in small floor area and needs only piping connections.

For Further Information Write To Dept. C-9

DE LAVAL

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

DE LAVAL PACIFIC COMPANY, Dept.
201 E. Millbrae Avenue, Millbrae, Calif.

CENTRIFUGES
PLATE HEAT EXCHANGERS
VIBRATING SCREENS
COMPLETE PROCESSES

Shake a Lot, Toss a Little ...Shake a Little, Toss a Lot

In seiving by hand, you intuitively adjust the amount and type of shaking and tossing to get optimum separation. Now this same full range of controlled motion is available in a high-capacity screen separator. Simply adjust three controls to obtain a predictable "3-D" screening action ranging from gentle nudging of easily-damaged products, to turbulent, intense exposure of powders, granules, or slurries to screen for rapid, efficient separations.

A review of the De Laval Syncro-Matic features reveals why it is rapidly finding use in such applications as:

- Scalping of liquid suspensions prior to centrifugal separation.
- Grading of fruits, nuts and diced vegetables.
- Thickening of wood pulp slurry.
- Classification of resin molding powders.
- Removal of spent grain in fermentation.
- Removal of fines from crystals.
- Separation of fibers from pulped food.

In all cases, the *particular* optimum combination of screening motion was determined by simple adjustment of control dials. When the De Laval Synchro-Matic is used for multiple separation processes, resetting of the motion controls is done in minutes. Positive-control action assures constant screening action regardless of load conditions.

The full versatility and effectiveness of the Syncro-Matic can be detailed to you by a De Laval representative. Drop us a line to have him call, but meanwhile, think about:

- Single, double or triple decks of easily-replaceable screens.
- "Infinite" range of calibrated control in *three* directions.
- Light, stainless steel construction.
- Quiet and almost vibrationless operation with few moving parts.

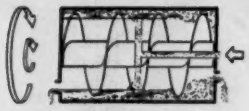
WATCH IT! YOUR NEURONS ARE STIFFENING!

"Electronic brains are not victims of habit. We humans, unfortunately, are. Life is easier when 'thinking' is channeled through well-worn familiar paths. That way, our conclusions seldom surprise us. And, like the hardening of our arteries, the neurons of our mind 'stiffen.'

"Do this. Be a **computer** for a day! Feed in the surprisingly **new** information on today's process equipment. Program it to point up the improvements **or complete changes** actually possible in your process. Naturally, we hope these limbered-up neurons will evaluate the information given here."

Fred Wheelwright, Industrial Sales Manager

2000G Centrifuge "Lies Down" to Tackle Continuous Separation of Slurries and Suspensions



Cylindrical Bowl

Conical Bowl

Minute solids particles to ½" lumps are instantly separated from liquid in a "2000G" environment. That's the centrifugal force generated by the De Laval "NX De-Sludger"—a hollow-bowl centrifuge that operates on a horizontal plane.

The continuous separation is effected by a screw conveyor which revolves slowly relative to the bowl wall, pushing solids to discharge ports at one end while the clarified liquid is discharged at the other.

Materials ranging from crushed pulps to mineral slurries are handled with equal ease by the De Laval "NX De-Sludger." Typical applications include "roughing" separation of liquid prior to conventional centrifuging, and controlled de-watering of slurries prior to further processing.

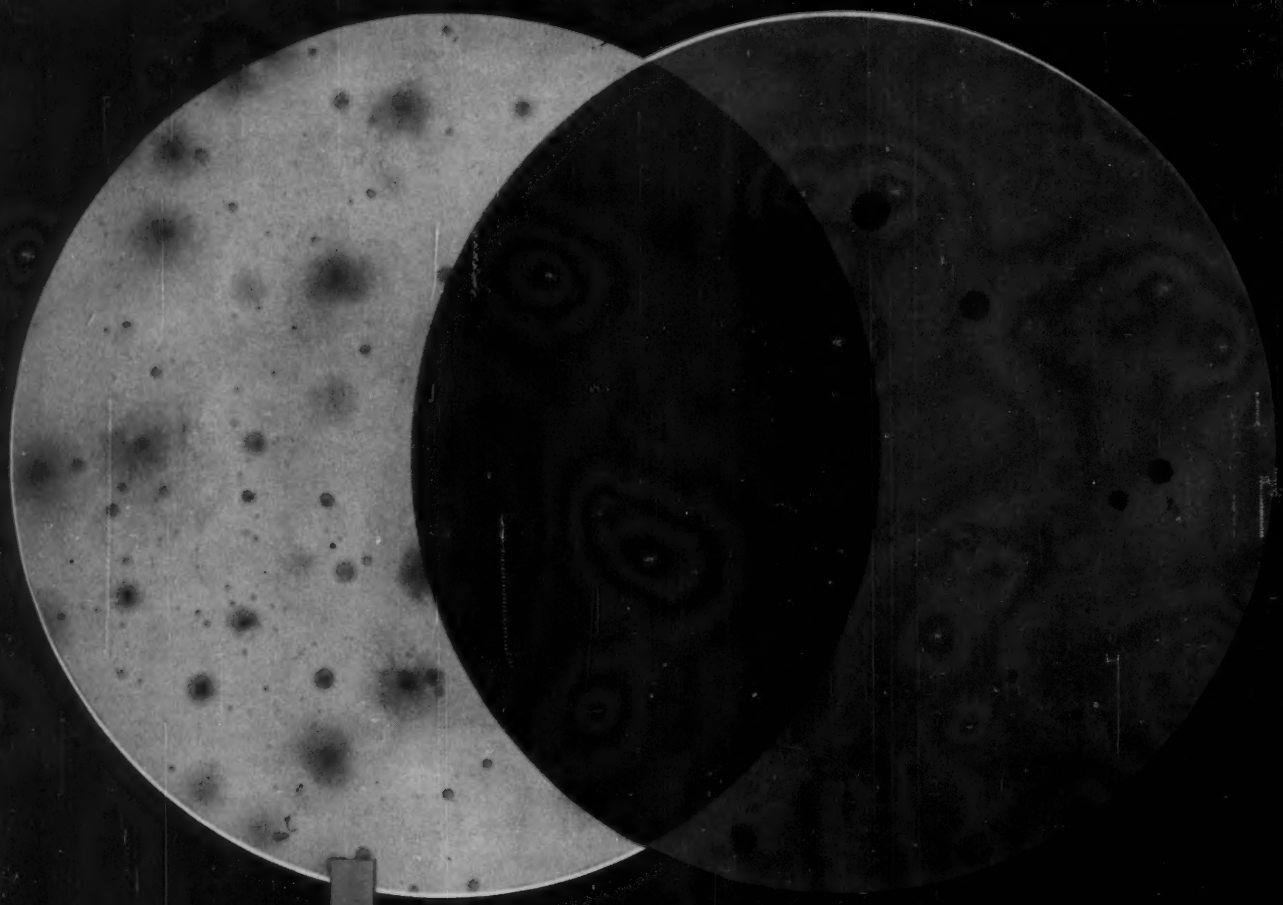
Relatively new, the De Laval "NX De-Sludgers" are replacing batch-settling and screening operations to give more effective trouble-free continuous separation. Design features include choice of cylindrical, conical or combination bowl types, adjustment of bowl liquid level and conveyor speed.

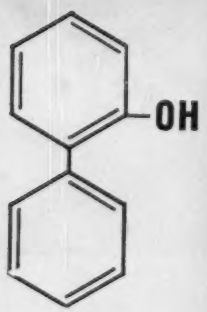
Would exposure to 2000G's plus continuous discharge solve a separation or concentration problem for you? We'll be happy to discuss it at no obligation. Just write!

Dow **C.P.I.** *file* **3**

EMULSIFICATION

EMULSION ADDITIVES are frequently necessary to preserve the desired emulsion characteristics. The leading emulsion problems controlled with additives are decomposition resulting from bacterial or fungal growth, and instability or undesirable color effects due to trace metal ion contamination.





MOST EMULSIONS contain materials which support the growth of bacteria or fungi. These microorganisms subsist on the emulsion components and produce metabolic waste products, many of them acidic. These waste products react with the emulsion components and decompose important constituents such as emulsifiers, dispersants, coupling agents, soaps, etc., thereby reducing the stability of the emulsion. Since many emulsion formulations are slightly alkaline, the waste acids can also affect the pH which frequently is critical to the stability of the emulsion. Effective control of both bacteria and fungi in emulsions is given by the Dowicide® products, a group of phenolic compounds the simplest of which is o-phenylphenol, Dowicide 1. Broad-spectrum bactericides, the Dowicide products are available with either water or oil solubility.

BACTERICIDE

PRESERVATIVE CONTROLS EMULSION BREAKDOWN AND ODOR PROBLEMS IN SOLUBLE OIL EMULSIONS

Dowicide A (sodium o-phenylphenate) has a long history of success as a preservative in soluble oil emulsions. Effective control of odor-causing bacteria and stability protection make it a valuable additive for metalworking cutting oils where contamination, odor, and corrosion are particular problems.

The concentration of Dowicide A that is generally necessary to preserve the emulsion is between 0.10 and 0.15% based on the total weight of the emulsion (water and oil). A practical method of attaining this concentration is to add 1 pound of Dowicide A to 100 gallons of emulsion (0.12%). This concentration will normally prevent emulsion breakdown and odor formation over an extended period even when machines are not operating. Bacterial protection is needed throughout the system. Badly contaminated systems should be cleaned and disinfected before treatment with Dowicide is started.

Latex paints, cosmetics, adhesives, and many other emulsion systems subject to organism attack are protected by treatment with Dowicide products. Full information on specific applications are available from Dow.

ADVANTAGES OF ADDING DOWICIDE TO AN EMULSION

- **Emulsions protected from bacterial decomposition**
- **Bacterial population held to a minimum**
- **Useable life of emulsion is extended**
- **pH of emulsion is not reduced**
- **Obnoxious odors prevented**
- **Discoloration due to organisms prevented**
- **Slime and sludge formation reduced**
- **Reduced corrosion due to bacteria acid in metal contact operations**
- **Reduced dermatitis caused by bacteria**

CHELATING AGENT

INACTIVATION OF TRACE METAL IONS PROTECTS STABILITY OF OIL, WAX, AND LATEX EMULSIONS

Versene® chelating agents added to aqueous emulsions are effective in preventing emulsion breakdown, rancidity, discoloration and coagulation. The Ca and Mg hardness ions affect stability, and Cu, Ni, Mn and other metallic ions can catalyze oxidation, which may lead to rancidity, discoloration, and coagulation. The amount of Versene necessary to stabilize aqueous emulsions depends on the hardness of the water used. Usually the Versene is added in a concentration of 0.05-0.2% by weight. Versene should be added as a 5-10% aqueous solution in order to avoid too heavy local concentration and possible emulsion breaking. The pH of the solution of Versene should be adjusted to that of the emulsion prior to addition.

In latex stabilization, Versene will prevent decomposition, precipitation, sludge formation, and putrefaction. Trace metal ions are complexed and their destructive influences are eliminated.

STABILIZATION OF AQUEOUS RESIN EMULSIONS. Traces of metal-ion contamination in aqueous resin emulsions frequently cause premature settling and instability. Also, in many systems, particularly those based on phenolic resins, traces of iron impart high, undesirable color levels through the formation of iron-phenolate-type complexes. Controlling these metal ions with chelating agents results in emulsions with improved shelf life and greater stability. The use of 0.5-1.0% of Versenex® 80 is usually sufficient to control color.

The Dow Chemical Company, Midland, Michigan
Chemicals Merchandising Dept. 427AK9-5

☐ For information on Dowicide products, ☐ "Keys to Chelation" Booklet

please specify application_____

Name_____

Position_____ **Company**_____

Address_____

City_____ **Zone**____ **State**_____

DOW

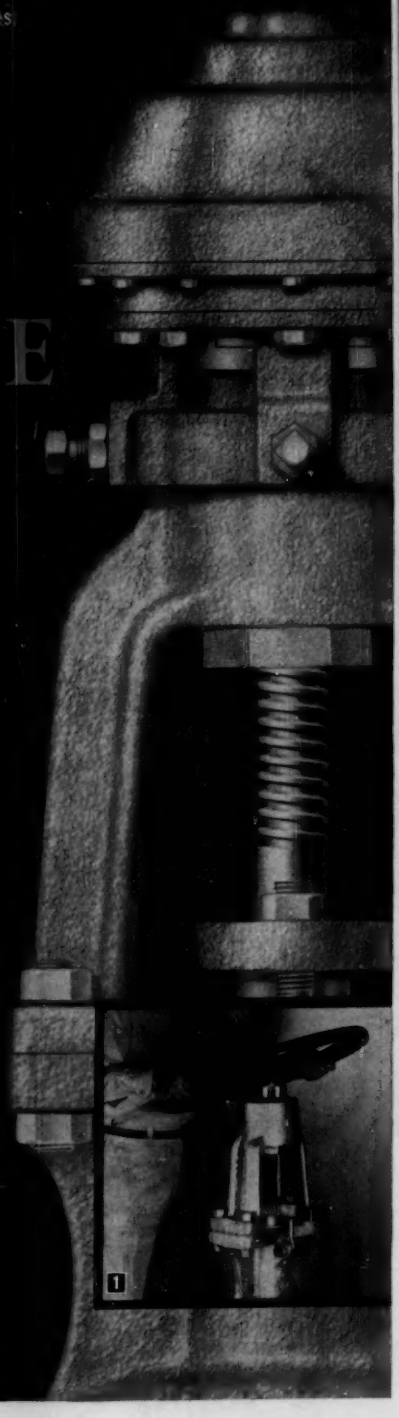
THE DOW CHEMICAL COMPANY
Midland, Michigan

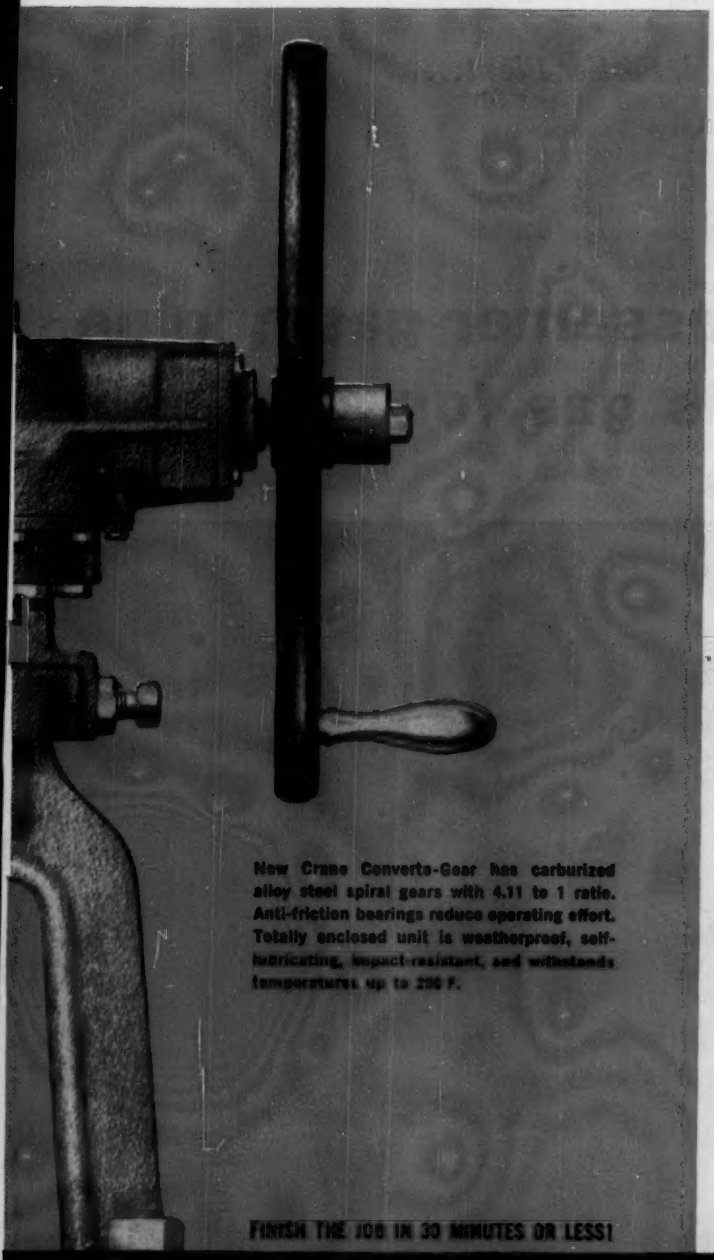
See "The Dow Hour of Great Mysteries" on TV.

CRANE
DIRECTION '70

a fast-moving program of planned expansion, product development, and streamlined distribution to help our customers meet the competitive challenges of the Sixties

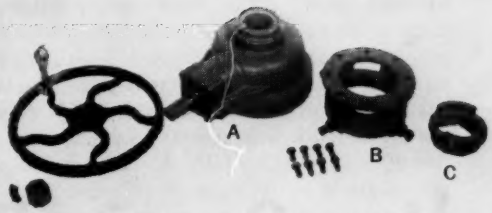
NEW! You can order this CRANE Converto-Gear Valve Operator from stock... install it in less than 30 minutes





New Crane Converto-Gear has carburized alloy steel spiral gears with 4.11 to 1 ratio. Anti-friction bearings reduce operating effort. Totally enclosed unit is weatherproof, self-lubricating, impact-resistant, and withstands temperatures up to 250 F.

FINISH THE JOB IN 30 MINUTES OR LESS!



Only three parts needed to convert your OS & Y valve to gear operation: (a) Crane Converto-Gear Operator, (b) adapter for mounting operator on valve, (c) yoke sleeve adapter. Handwheel and mounting bolts furnished with conversion kit.

Now you can convert to rapid, easy gear operation on many of your Crane iron and steel gate valves without removing them from the line! Changeover is simple and fast with Crane's new Converto-Gear Operator.

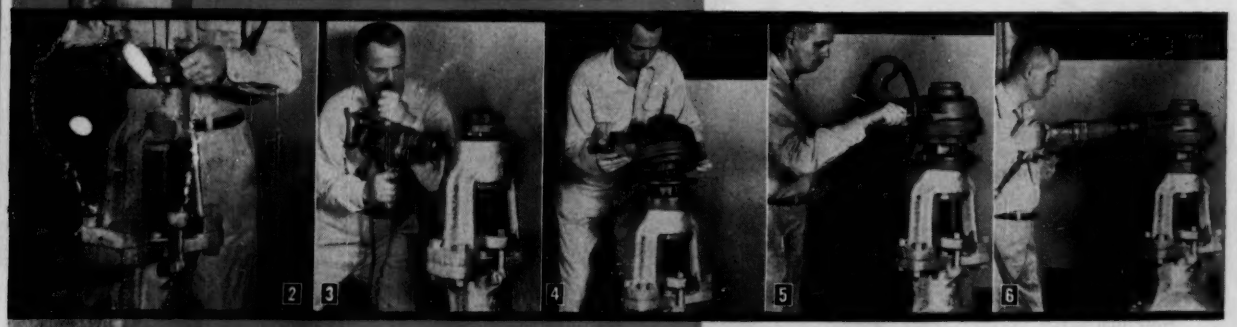
Your Crane Distributor can give you complete information on this brand-new idea in gear operators for gate valves. The Converto-Gear is standard and universal, readily mounted on Crane iron and steel gate valves in sizes from 6-inch to 36-inch, in outside screw and yoke or non-rising stem patterns.

And new orders for gear operated valves can be filled with unprecedented speed because the Converto-Gear can be supplied on valves right from stock. No special yoke castings or brackets are needed . . . just the basic gear operator and a simple two-piece adapter.

CRANE

CRANE CO., INDUSTRIAL PRODUCTS GROUP
4100 S. KEDZIE AVE., CHICAGO 32

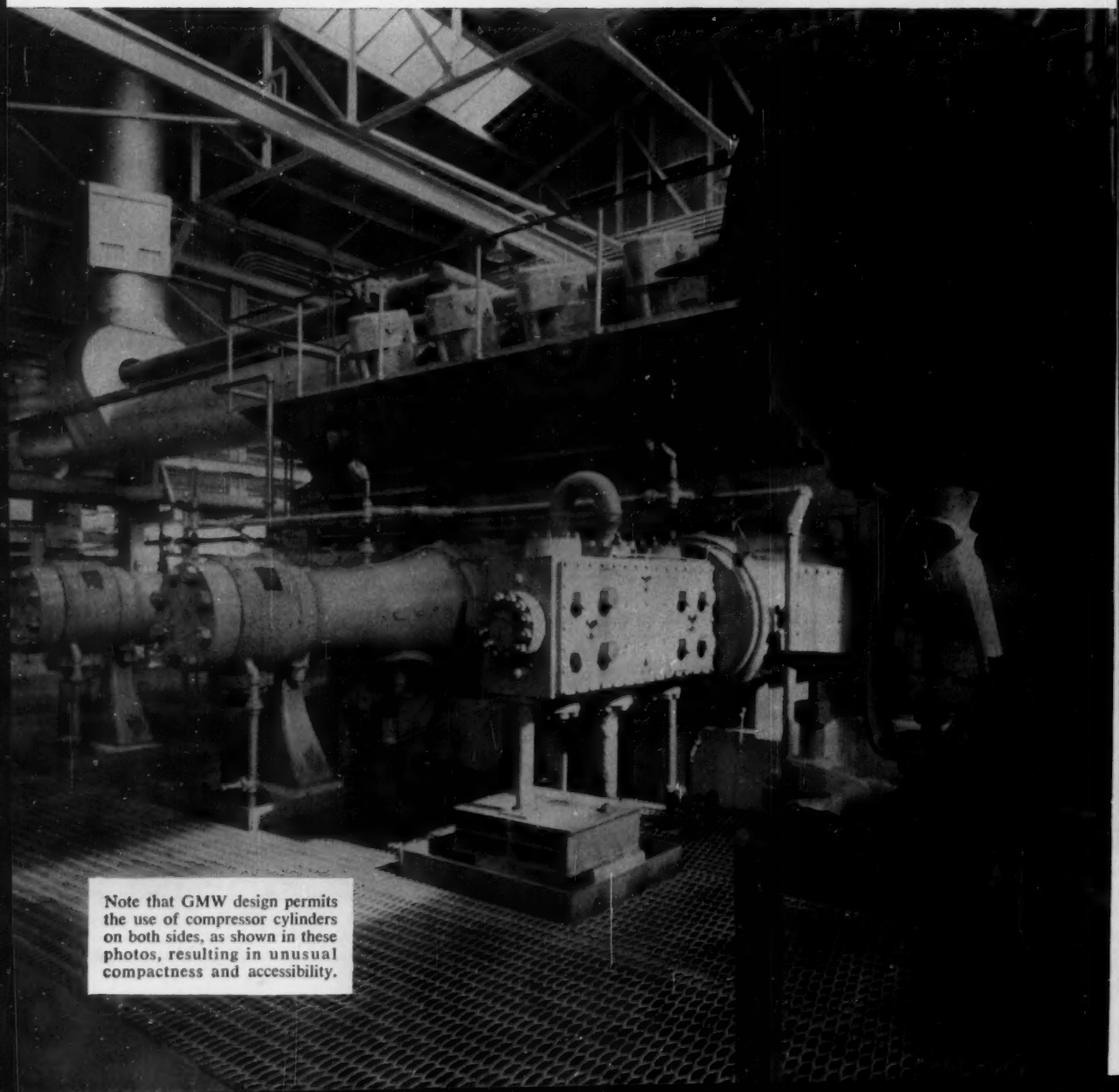
VALVES • ELECTRONIC CONTROLS • PIPING
PLUMBING • HEATING • AIR CONDITIONING
HEAT EXCHANGERS • CYCLOTHERM® BOILERS



To convert your OS & Y valve, (1) remove the handwheel, (2) mount the yoke sleeve adapter, (3) countersink 4 holes for the Converto-Gear adapter, (4) bolt the adapter in place and attach your Crane Converto-Gear Operator, (5) and you're ready for smooth, manual operation, (6) or fast operation with an air or electric power operator.

Report from American Cyanamid, Fortier Plant...

How Cooper-Bessemer gas engine boost synthesis gas for ammonia



Note that GMW design permits the use of compressor cylinders on both sides, as shown in these photos, resulting in unusual compactness and accessibility.

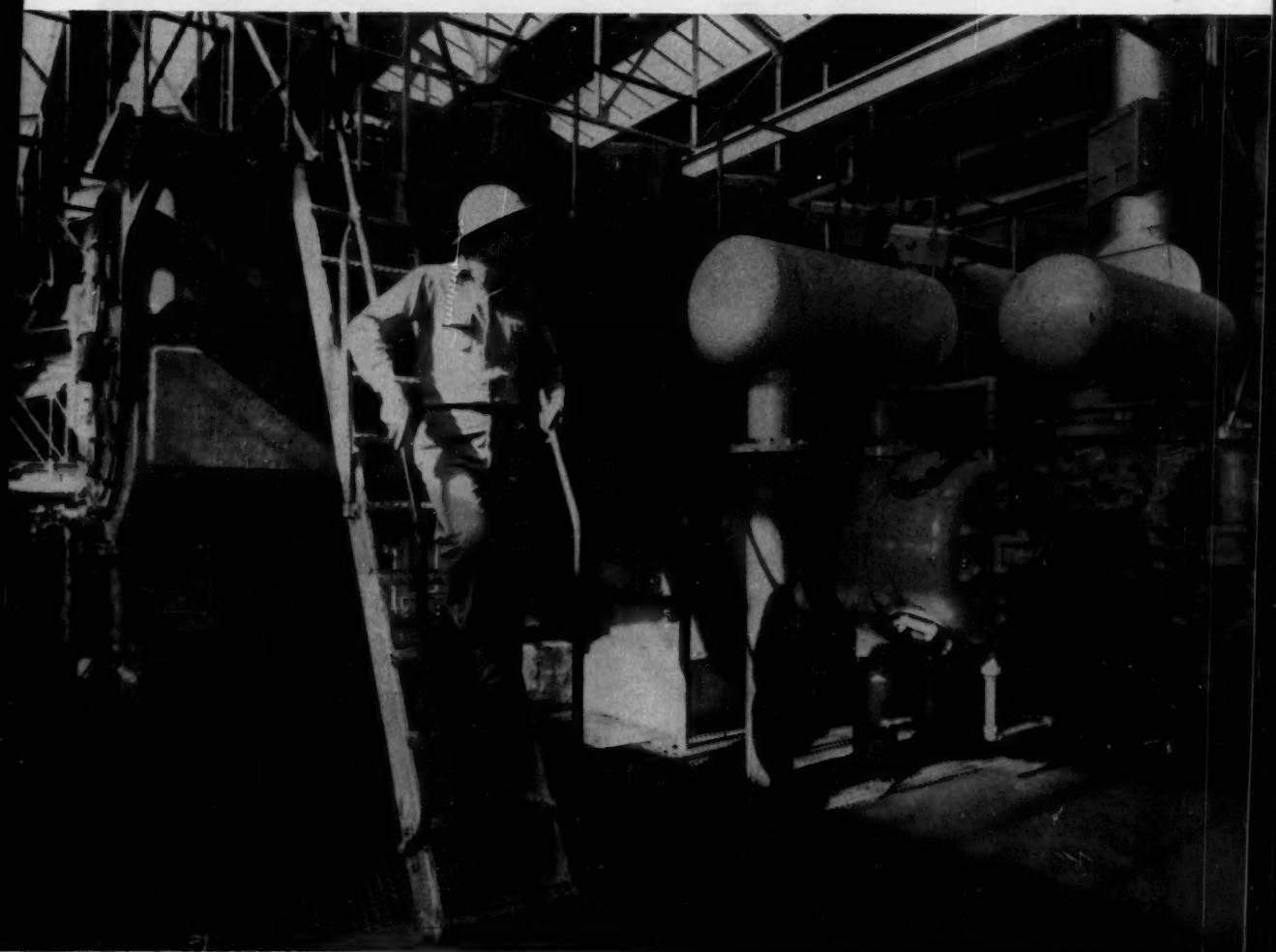
compressors to 5000 psi

These photos show both sides of one of the two Cooper-Bessemer 2500 hp GMW gas engine compressors at the Fortier Plant of American Cyanamid Company, Avondale, Louisiana. In the production of anhydrous ammonia, these 4-stage units compress 6000 cfm of synthesis gas from 60 psi to a discharge of 5000 psi. The left-hand view shows the high pressure cylinders; that on the right shows the low pressure side. The four stages of compression from 60 psi are (1) to 225 psi, (2) to 670 psi, (3) to 1500 psi, (4) to 5000 psi.

The two units have been operating since 1954, 24 hours a day, 340 days a year.

The anhydrous ammonia produced at the Fortier Plant is used by American Cyanamid in the manufacture of Acrylonitrile and is sold to fertilizer plants and other chemical companies.

Find out how Cooper-Bessemer can help *you* plan compression and power facilities. Write for copy of bulletin, "Cooper-Bessemer Equipment for Chemical Plants."



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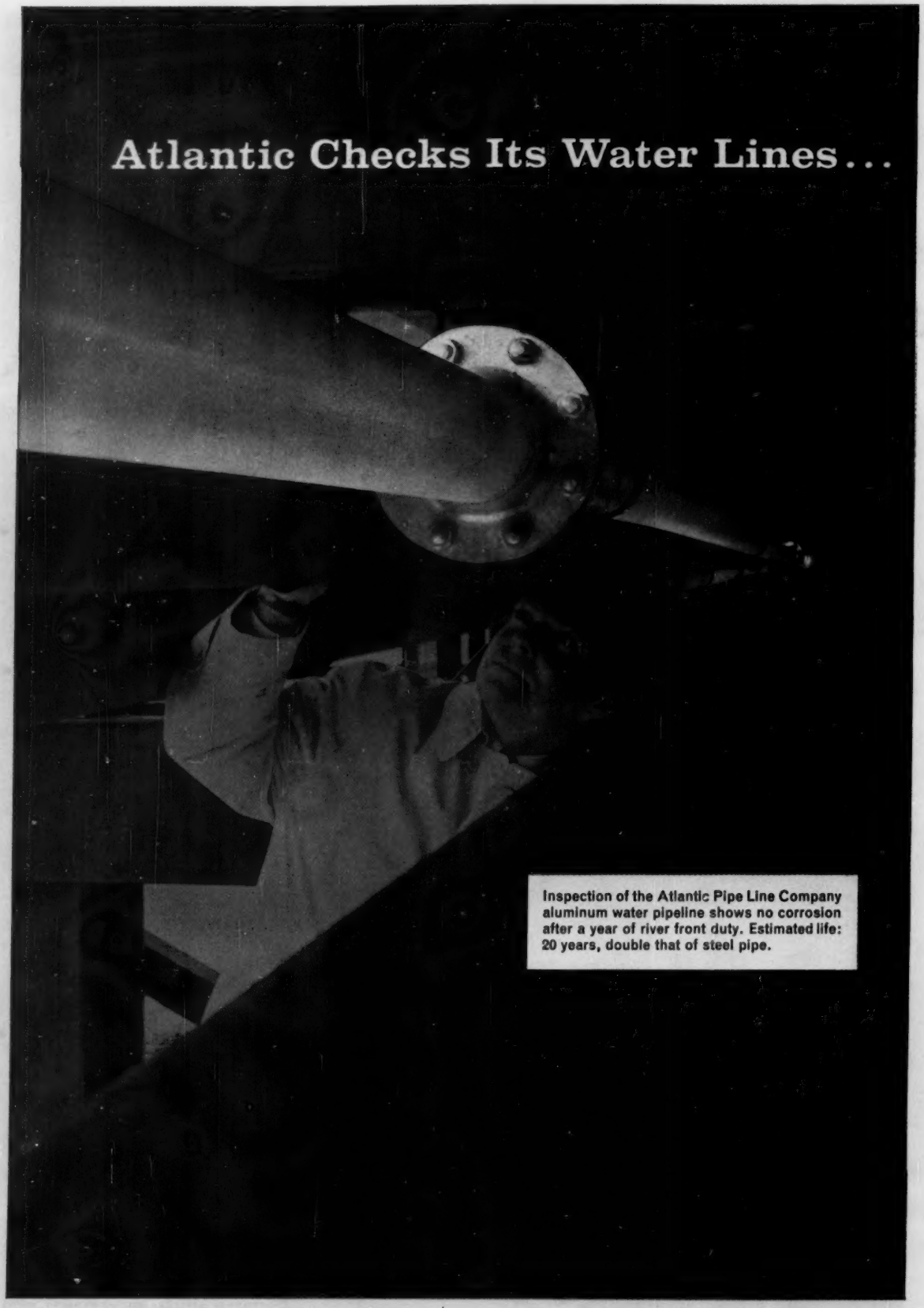
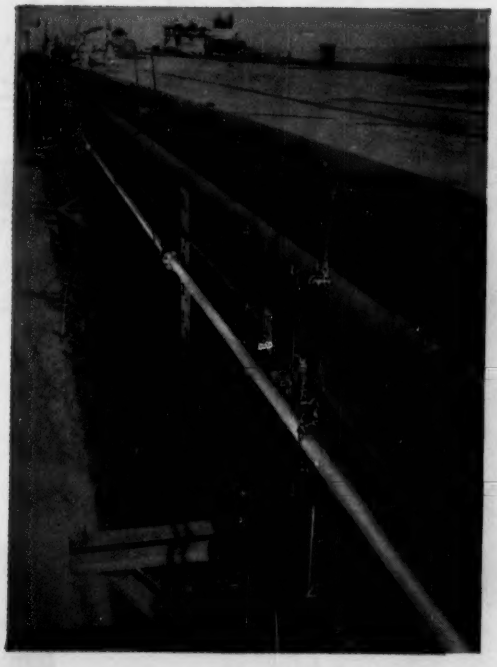
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

Atlantic Checks Its Water Lines...



Inspection of the Atlantic Pipe Line Company aluminum water pipeline shows no corrosion after a year of river front duty. Estimated life: 20 years, double that of steel pipe.

...and estimates aluminum process pipe will last twice as long as steel in dock duty!



Aluminum pipe stays bright, clean, and strong. It collects no scale inside, permitting use of smaller diameter pipe. Light weight simplified installation, eliminated need for hoist.

In November, 1958, the Atlantic Pipe Line Company installed an aluminum pipeline to supply water to ships and barges near Philadelphia. This was the first aluminum water line the company had used; it was Reynolds 4" Schedule 40 Pipe.

A year later, Atlantic checked the pipe, and judging from its condition, estimated its life to be 20 years or more. Steel pipe in the same service lasts about 10 years.

The extra longevity of aluminum process pipe in this service is just one of several advantages it has provided. Because aluminum pipe will not scale or collect corrosion products, Atlantic could use 4-inch pipe, compared to a 6-inch diameter needed with steel pipe.

Easy installation is another advantage with lightweight aluminum pipe. Atlantic's pipeline was fabricated in the shop, and just two men installed it working from a single barge. Hoisting equipment is necessary to install equal lengths of steel pipe.

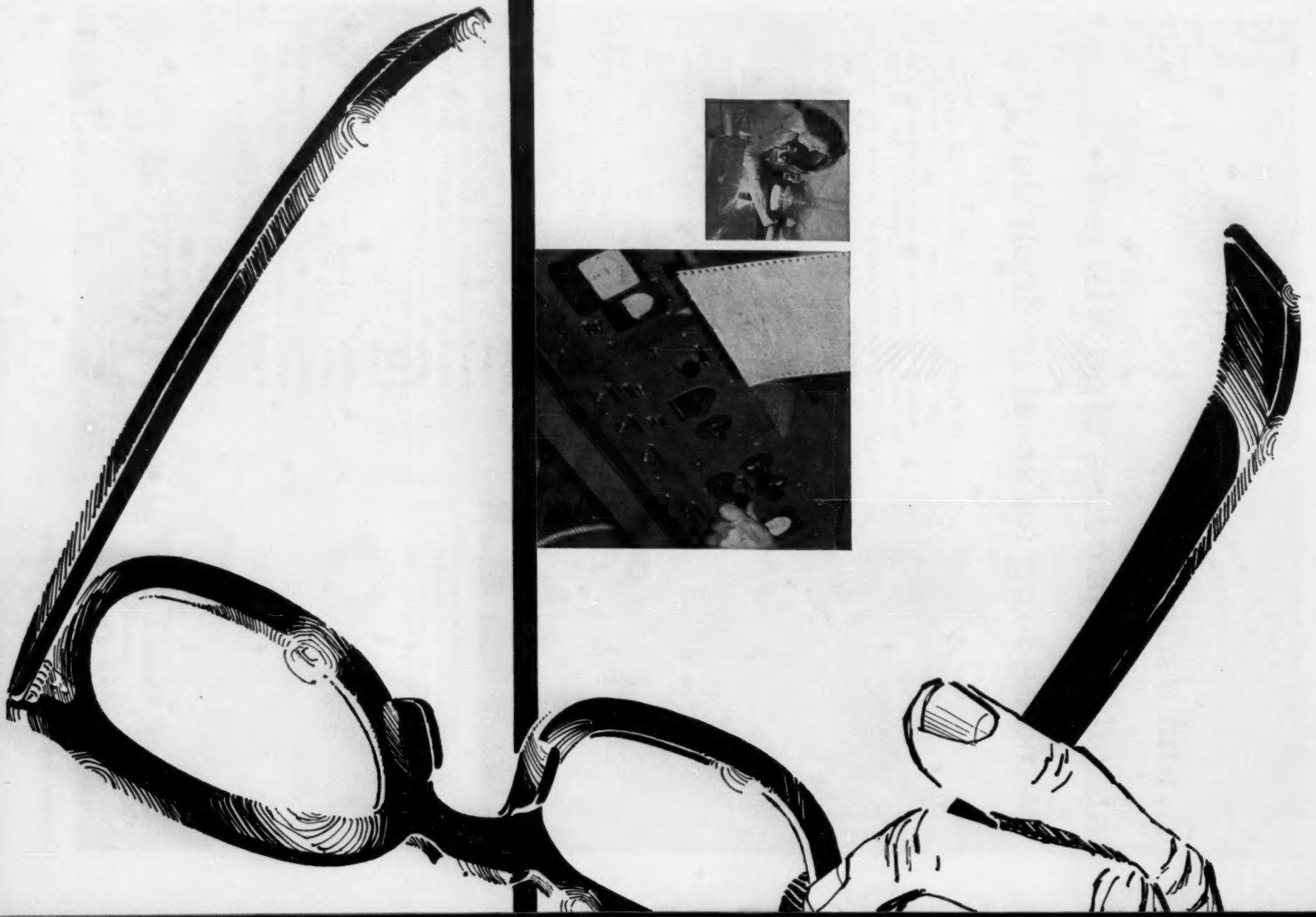
Finally, Atlantic enjoys considerable savings in maintenance with the Reynolds Aluminum Process Pipe. Where steel pipe needs painting every few years for protection against spray, rust, and brackish water corrosion, aluminum needs none at all. After a year of carrying drinking water along the river front, the aluminum pipe line showed no exterior corrosion.

Add up the advantages: longer service, easier installation, less corrosion, less maintenance. When you consider all the long-term factors, you have to consider aluminum process pipe.

For details on aluminum process pipe, or aluminum for any process application, contact your local Reynolds office, *or write Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Virginia.*

REYNOLDS ALUMINUM

Watch Reynolds new TV show "Harrigan & Son", Fridays, starting October 7; also, "All Star Golf", Saturdays, resuming October 15—ABC-TV. And on Sunday, October 16, be sure to see the exclusive showing of America's new 1961 cars on The National Automobile Show, direct from Detroit over CBS-TV, 6 to 7 P.M. EDST.



"security" clearance

Take all possible care to control the quality of chlorine and caustic up to the point of shipment. Follow proper loading procedures to the letter. Then go one step further . . .

At Wyandotte, this means putting a sample from each tank-car shipment of chlorine or caustic through a battery of exacting tests, as a "security" clearance.

These samples are subjected to qualitative and quantitative analyses. They measure up, or the car doesn't go out.

Few samples fail to clear this final check. The steps that precede it provide virtual assurance of quality. But because the possibility, however remote, exists . . . we feel that the practice is warranted.

Dependable quality is a point of pride at Wyandotte. So is dependable service. Significantly, both of our chlorine-caustic plants are on major waterways to gain the advantage of low-cost water transportation. At Geismar, in the South, we are on the Mississippi . . . and close to the Gulf. At Wyandotte, in the North, we are on the Detroit River, and have direct access to the Great Lakes and the St. Lawrence Seaway. Railways and highways also go out from these two plants to four-fifths of the productive capacity of the U.S. and Canada.

The benefits to users of Wyandotte Chlorine and Wyandotte Caustic in its many forms are plain. We can ship economically and with dispatch . . . by barge or ocean tanker, truck or tank car. May we discuss the possibilities with you? *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

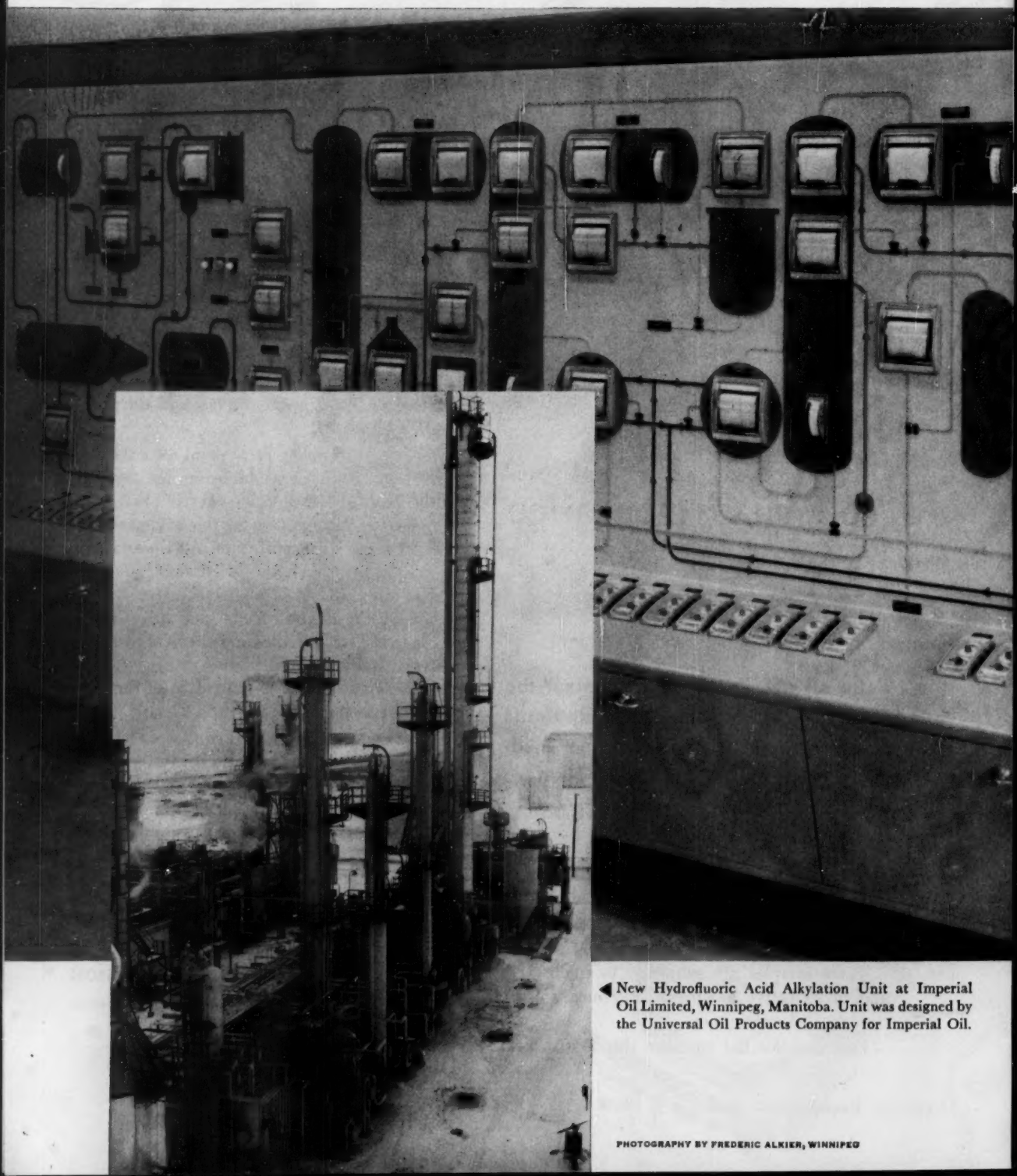
WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION

Pacing progress with creative chemistry®

at Imperial Oil Limited

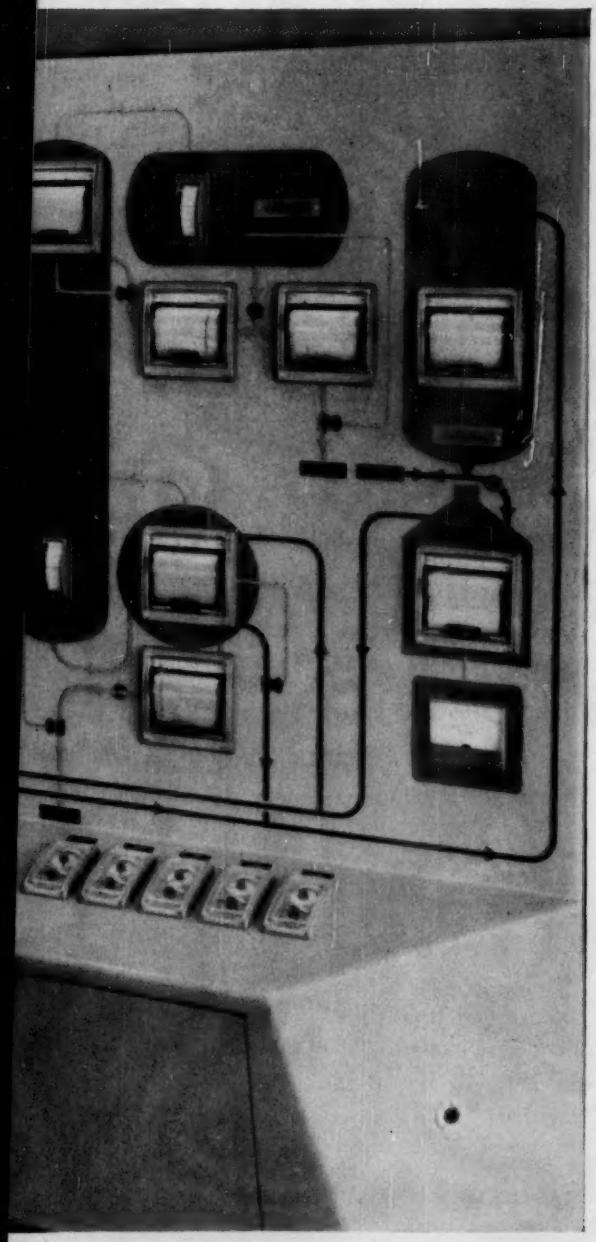
They wanted a low
they chose Foxboro



◀ New Hydrofluoric Acid Alkylation Unit at Imperial Oil Limited, Winnipeg, Manitoba. Unit was designed by the Universal Oil Products Company for Imperial Oil.

PHOTOGRAPHY BY FREDERIC ALKIER, WINNIPEG

maintenance electronic system... Electronic Consotrol instrumentation



▲ **FOXBORO ELECTRONIC CONSOTROL PANEL** at Imperial Oil includes 32 control loops. 3" x 6" Control Stations are so compact they are mounted on panel console, while recorders are mounted directly in the graphic diagram above.

problems of "frozen" air and vacuum tubes eliminated in new HF Alkylation Unit at Winnipeg, Manitoba

There were significant reasons for installing Foxboro Electronic Consotrol* Instrumentation on Imperial Oil's new HF Alkylation Unit in Winnipeg, Manitoba.

First — Foxboro electronics completely eliminated their problem of air supply — particularly vexing in a climate where the temperature drops below freezing 9 months out of the year.

And second — they like Foxboro's "all solid state" feature, because they'll never have an instrument failure due to a burned out vacuum tube.

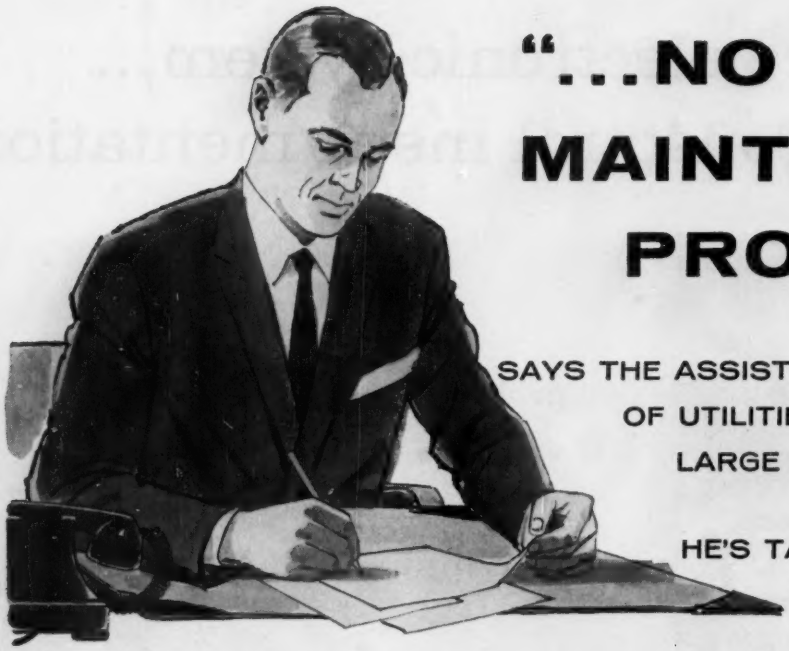
Imperial Oil also appreciates the compactness of Foxboro electronic control panels. Compact 3" x 6" controllers are located on sloping panel console — 4-inch strip chart recorders are integrally-mounted in graphic diagram. With a minimum of searching, the operator knows how the process stands.

If speed of response, sensitivity, and reliability play an important role in your process, it will pay you to investigate Foxboro Electronic Consotrol instrumentation. Ask your Foxboro Field Engineer about it. Or write for Bulletin 21-10. The Foxboro Company, 369 Neponset Avenue, Foxboro, Massachusetts.

*Reg. U. S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.



"...NO MAINTENANCE PROBLEMS"

SAYS THE ASSISTANT SUPERINTENDENT OF UTILITIES OF A LARGE STEEL MILL*

HE'S TALKING ABOUT

CONOFLOW Series LB

When approached for a comparison of maintenance costs between Conoflow LB control valves and other control valves, he exclaimed, "There are no costs of maintenance on LB valves. We've never had any trouble with them!"

Such dependable, maintenance-free performance saves a plant like this tens-of-thousands-of-dollars in downtime annually. Consider the various trades that have to be called into action or held idle when a control valve must be taken out of a line, the capital tied up in idle machines, and loss of production.

Did you ever figure out what an hour's downtime costs in *your* plant? Wherever such figures are known, the Conoflow LB control valve makes "dollars-and-sense" savings that can't be beat.

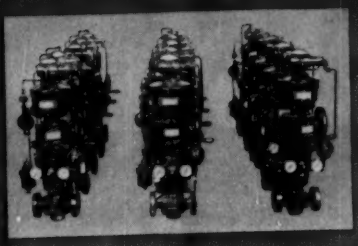
We show here only a few of hundreds of "testimonial" installations where users enthusiastically endorse Conoflow LB Valves.

Let our representative give you an actual demonstration and tell you more . . . or write today for Bulletin LB, Conoflow Corporation, 2100 Arch St., Philadelphia 3, Pa.

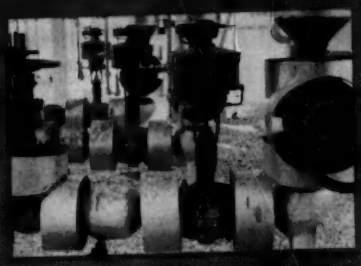
*Name on request

VISIT CONOFLOW BOOTH 1445, New York 1960 ISA SHOW, September 26-30

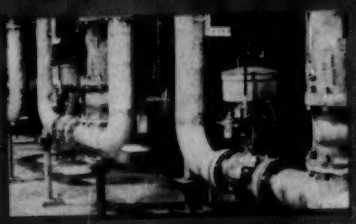
CONOFLOW CORPORATION . . .



Part of a shipment of 62 Conoflow LB Valves destined for the Union Miniere du Haut-Katanga's Congo plant, one of the world's largest copper plants.

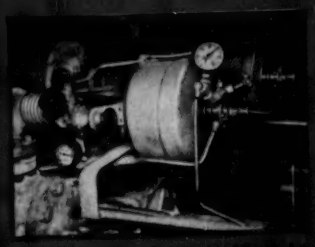


Conoflow LB Valves at [illegible] company's new La Verne, [illegible] and sundorn gasoline [illegible] Refinery for J. P. Pritchard & [illegible]

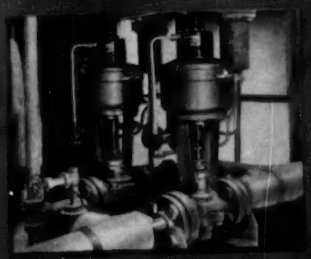


Conoflow LB Valves on a critical control application at American Cyanamid's new acrylic fiber plant in Santa Rosa, Florida.

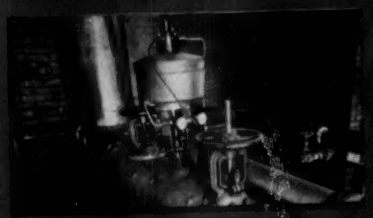
CONTROL VALVES



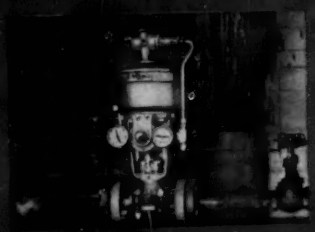
Conoflow LB valves provide tight shutoff for steam lines operating high pressure differentials at the [illegible] Paper Company plant in Longview, Washington.



Nine [illegible] 600 Conoflow LB valves operate in the Lancaster, Pa. plant of Armstrong Cork Company. Valves shown have been on [illegible] temperature control service for [illegible] years.

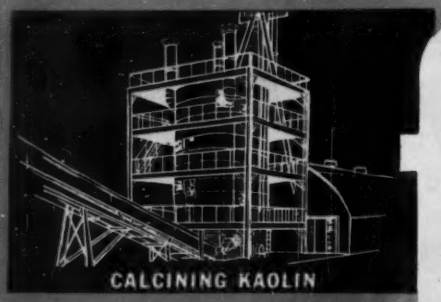


This Conoflow LB valve is handling hot coal tar at temperatures to 720° F. in the Bethlehem, Pa. plant of the Barrett Div., Allied Chemical & Dye Corporation.

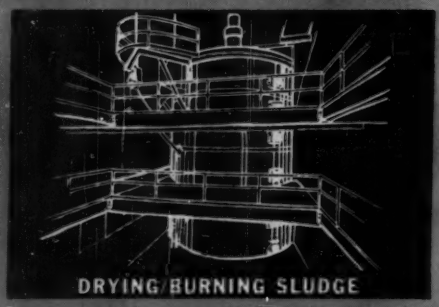


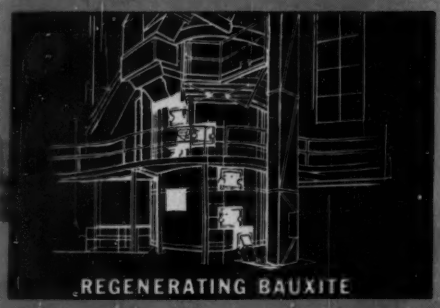
[illegible] Conoflow LB) are the [illegible] we ever found for tight shutoff on our maleic acid lines" [illegible] Instrument Foreman of a large [illegible] coast chemical plant.

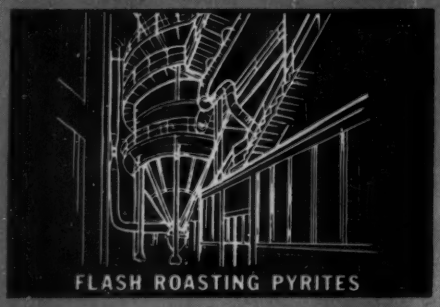
FOREMOST IN FINAL CONTROL ELEMENTS


CALCINING KAOLIN

ROASTING NICKEL ORE


DRYING BURNING SLUDGE


REGENERATING BAUXITE

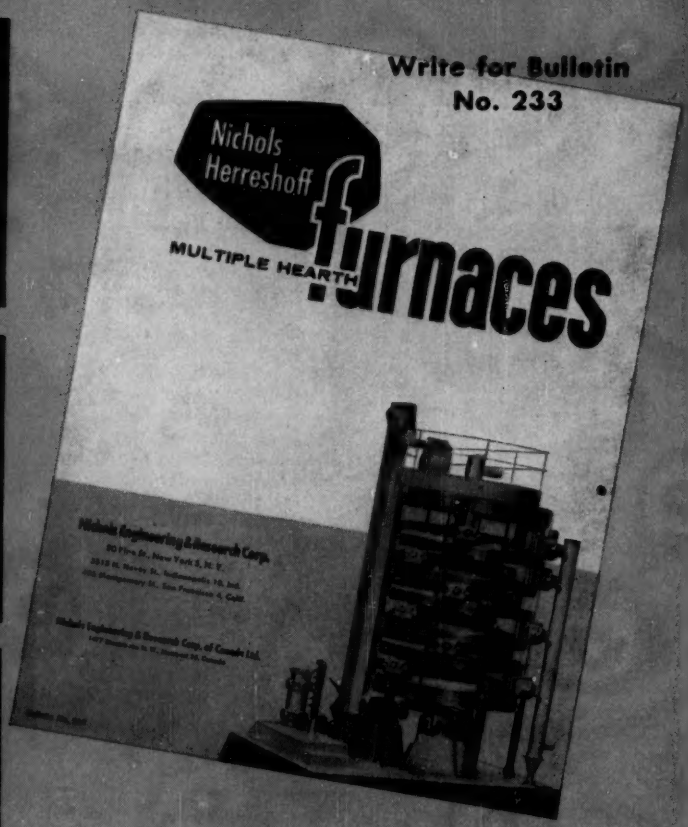

FLASH ROASTING PYRITES

Treating-Processing furnaces

Nichols Herreshoff* and Bethlehem Wedge multiple hearth furnaces and Nichols Freeman Flash Roasters are standard equipment throughout the world for calcining, drying, roasting or reducing ores, concentrates, sludges or slurries.

For a single unit or a complete thermal processing plant—consult Nichols. Laboratory services, custom roasting and pilot plant equipment are available.

Write for Bulletin No. 233



Nichols Engineering & Research Corp.
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3513 N. Hovey St., Indianapolis 18, Ind.
405 Montgomery St., San Francisco 4, Calif.
1477 Sherbrooke St. W., Montreal 25, Canada

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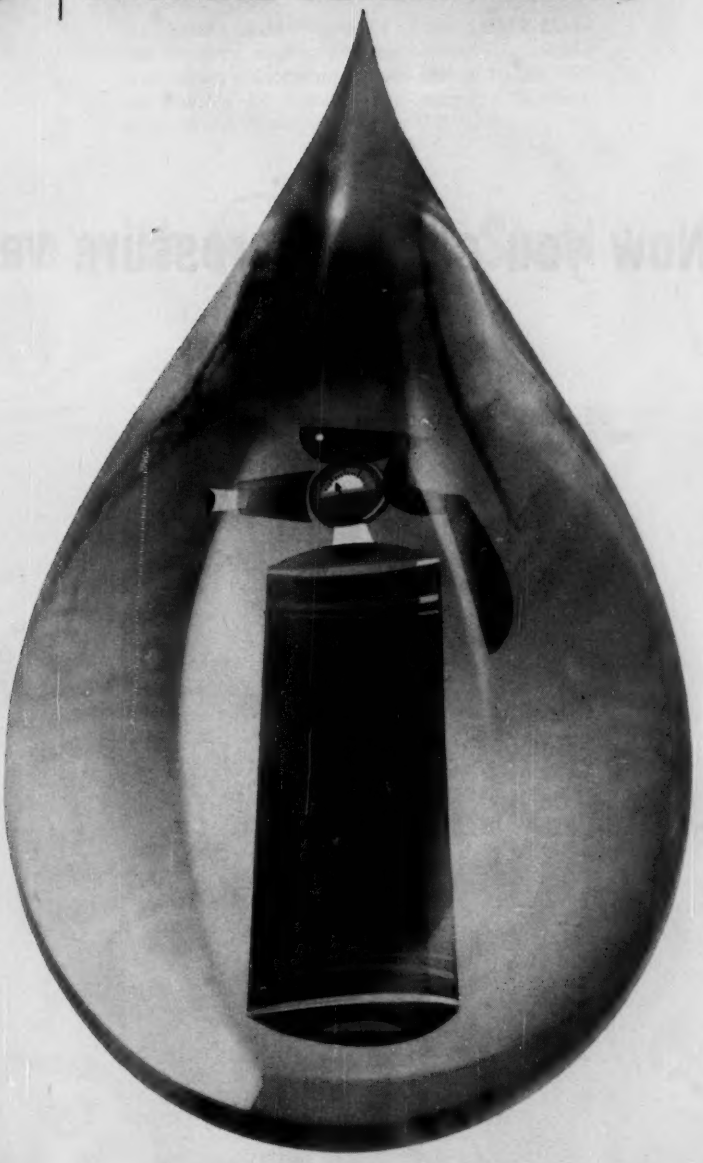
DOW | **BROMINE DEVELOPMENTS**



FIGHT FIRE FASTER WITH BROMINE

Organic compounds utilizing bromine became important fire-fighters during World War II when the armed forces urgently needed quick-acting fluids to snuff out hard-to-handle fires fast. The first such compound developed was immediately used widely by the military, and subsequently, found growing commercial use as well.

For brominated organic compounds, this development opened up a new potential for a new field. Today, several brominated compounds have proved excellent for quickly smothering fire. And new ones are being developed. One bromofluoro compound, for example, shows great promise for speeding the work of crews fighting aircraft crash fires.

Many other brominated compounds are under continual study at Dow because of their unique fire extinguishing and retarding properties. In other applications, bromine and brominated compounds serve as chemical intermediates in thousands of reactions. And attention recently has been directed toward new bromine uses in building dense fluids.

Dow's first product nearly 70 years ago was bromine. Today, in addition to high-purity elemental bromine, Dow's list of brominated compounds tops the hundred mark, with new ones under intensive study. Dow is eager for research assignments to fully develop bromine's potential value to your production. For more information about how bromine can serve you, write THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Merchandising Dept. 653AK9-5.

See "The Dow Hour of Great Mysteries" on 8 TV

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

This mark tells you a product is made of modern, dependable Steel.

Now you can cut pressure vessel weight

The use of 299 tons of USS "T-1" Steel in these two Hortonspheres saved 216 tons of carbon steel and 42% in shipping costs. Designed and erected by Chicago Bridge & Iron Company for storing propane gas in Venezuela. These tanks were designed to the old code limits, but under the new code limits they could have been made up to 9.5% lighter.

Revisions in case 1204-4 of the ASME Code for boilers and pressure vessels increase maximum allowable stress value to 28,750 psi for "T-1" Steel. This permits further reductions in weight up to 9.5%.

even more with USS "T-1" Steel

The new figure of 28,750 psi represents an increase of 9.5% over the previous maximum allowable stress value of 26,250 psi which applied to USS "T-1" Constructional Alloy Steel used in pressure vessels. This means that USS "T-1" Steel can be used to reduce weight even more than it did before in stationary vessels or truck tanks.

The steel frequently used in welded, unfired pressure vessels is ASTM A-285-Grade C. This steel can be used with a maximum allowable design stress of 13,750 psi. From this, you can see that the allowable stress for "T-1" Steel is 2.1 times greater. To put it another way, plates of "T-1" Steel in a pressure vessel need be only half the thickness of A-285-C plates to withstand the same stress.

15% overall savings possible with "T-1" Steel

USS "T-1" Steel permits a 50% reduction in the amount of steel used in the vessel; this results in large savings in the cost of structural supports and foundations, welding, freight, handling costs and the elimination of stress relieving costs.

In a recent design, pressure vessels designed of both A-285-C steel and "T-1" revealed the following cost analysis:

	Use of "T-1"
Weight of steel	**saved 50%**
Cost of steel	**only 20% more**
Fabrication cost	**saved 40%**
Freight	**saved 50%**
Amount welding wire	**saved 60%**
Total savings	**15% cheaper overall**

These savings, plus USS "T-1" Steel's unique combination of toughness at low temperatures, high strength at elevated temperatures, and weldability, offer the pressure vessel designer the *only* material of this high strength level possessing *all* the qualities so important in the pressure vessel field.

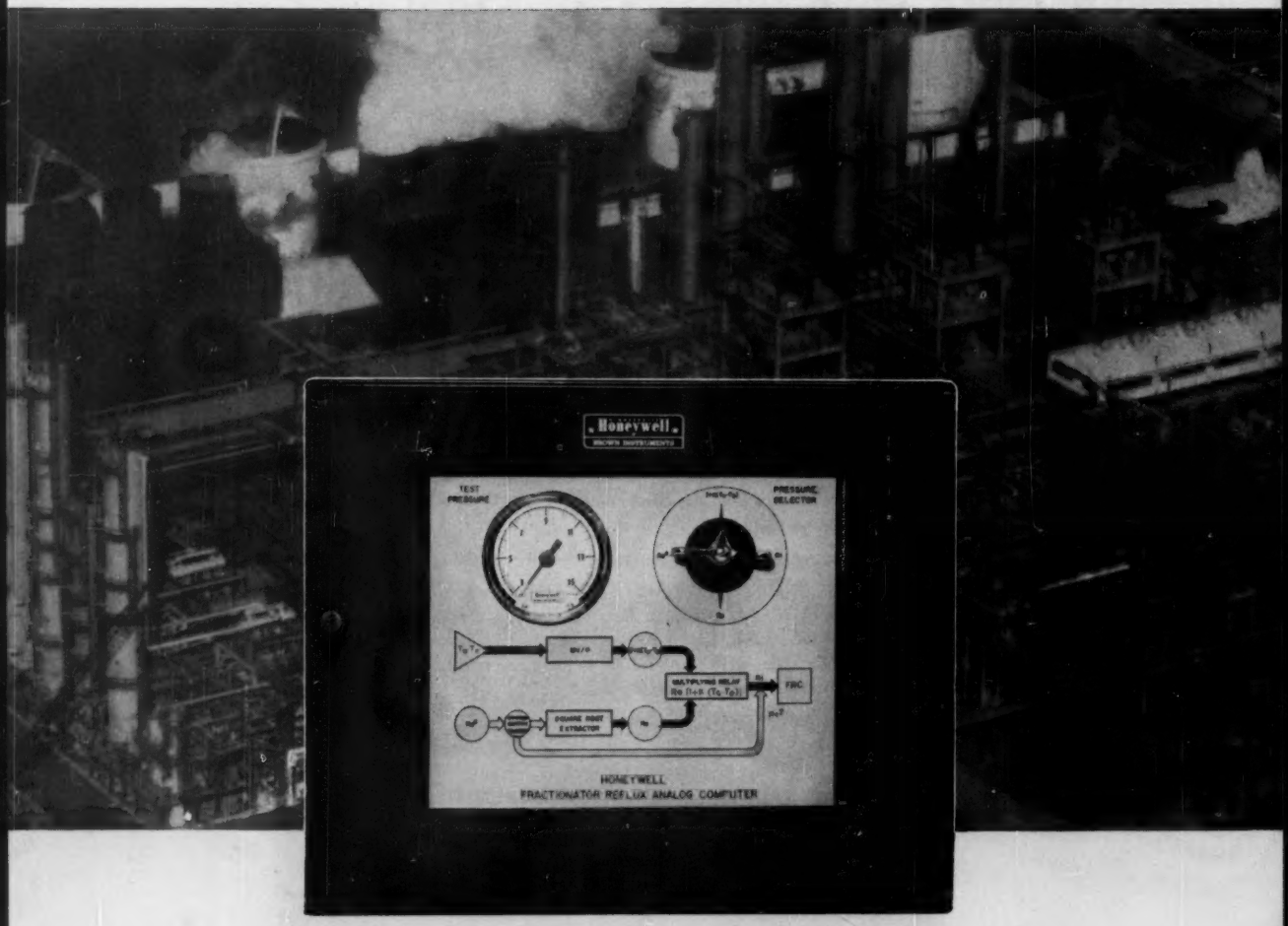
For more information, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and "T-1" are registered trademarks

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
National Tube Division—Pittsburgh
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

Stabilize Fractionating with new Honeywell



HONEYWELL *FRAC* CONTROLLER IS EASY TO USE AND MAINTAIN

- Standard Honeywell components, packaged in a standard Honeywell strip chart recorder case—completely wired and internally piped.
- Only four simple, easily accessible process connections required to put the unit in operation.
- Chassis pulls out for front-of-case servicing, simplifying adjustment and maintenance for your instrument technicians.

COMPONENTS

MV/P (millivolt-to-pressure) Transmitter

- Fully transistorized
- Continuously sensitive to temperature change
- Constant voltage supply
- Simple span and zero adjustments

Pressure selector and test pressure gage

- Provide check of all pneumatic pressures within the computer for simplified trouble shooting.

By-pass switch

- Permits switching from *FRAC* control to conventional external reflux flow control.

Column Operation

*FRAC** Controller

- **Easily installed and maintained by present instrument technicians**
- **Savings realized justify installation**
- **Tamper-proof design**

This new Honeywell control system immediately adjusts column operation to the effects of ambient temperature on overhead product condenser and external reflux. It continuously computes internal reflux flow, to maintain the most efficient, economical fractionating tower operation.

The new method, originally developed and licensed by Phillips Petroleum Company, utilizes a simple Honeywell analog computer employing standard Honeywell electric and pneumatic instrument components.

By correcting instantly for temperature deviation, the new control system offers the following economies.

- Less reboiler heat is required, because large surges of internal reflux that would lower temperature are eliminated.
- Reduction in off-specification product minimizes re-runs and the need for intermediate storage.
- Closer control permits fractionator to operate closer to the flooding point.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

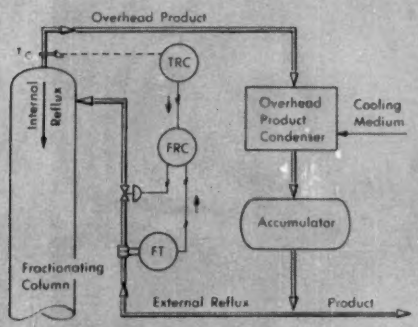
**Fractionator Reflux Analog Computer. Trademark, Minneapolis-Honeywell Reg. Co.*

from Honeywell... ANOTHER DIAMOND JUBILEE PRODUCT

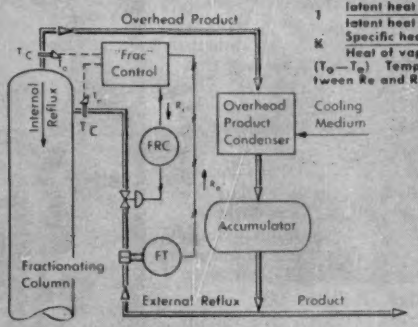
Honeywell

First in Control

SINCE 1885



PROBLEM with existing fractionator control systems—Column is upset when temperature of external reflux is indirectly affected by changes in atmospheric conditions or in the temperature of the cooling medium to the condenser. Result: off-spec product, wasted reboiler heat, lower fractionator capacity.



$R_i = R_e[1 + K(T_o - T_e)]$

R_i Internal reflux

R_e External reflux

$\frac{\text{latent heat of vaporization of } R_e}{\text{latent heat of vaporization of } R_i}$

K Specific heat of R_e / Heat of vaporization of R_i

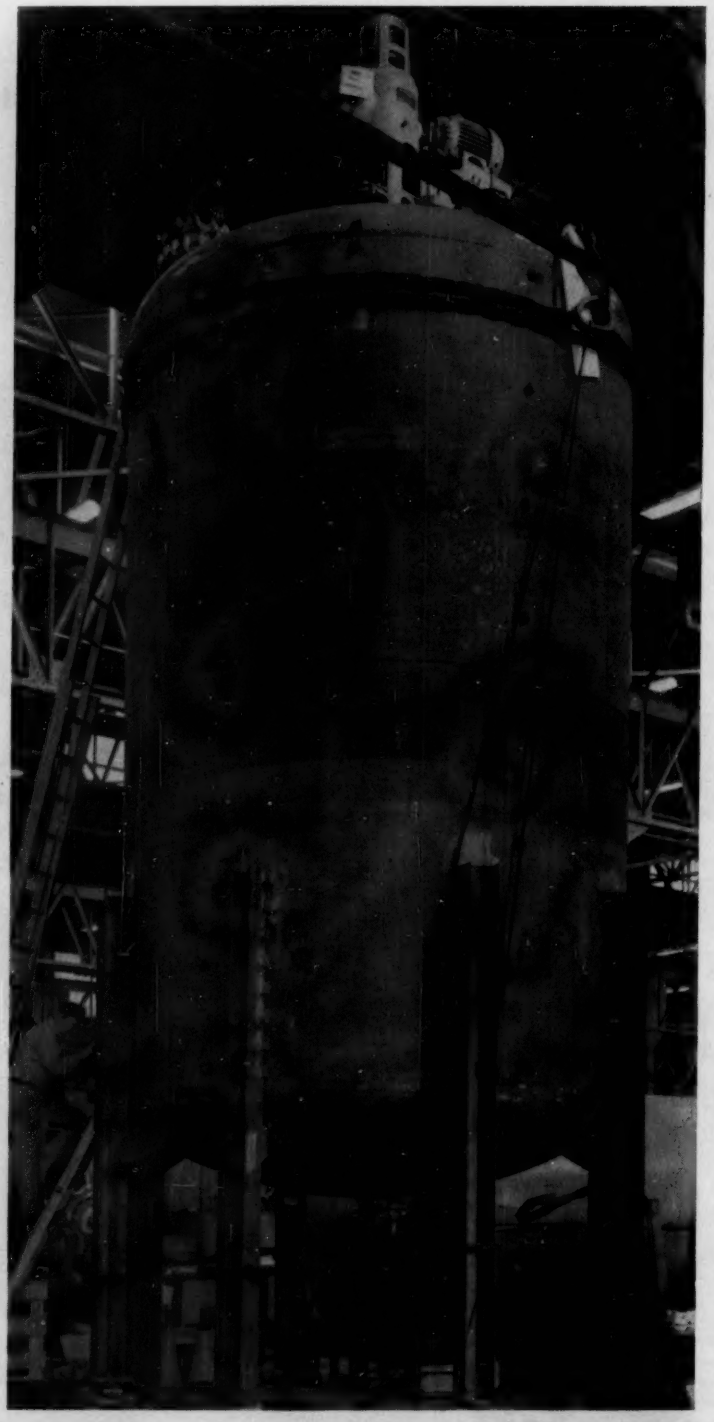
$(T_o - T_e)$ Temperature difference between R_e and R_i

SOLUTION: FRAC Controller (1) measures external reflux flow rate (R_e) and the temperature difference between the overhead product (To) and the external reflux (T_e); (2) computes internal reflux flow rate (R_i); and (3) holds it constant by adjusting external reflux flow rate for efficient fractionator operation.

FLUIDICS* AT WORK

BIG

Glasteel Tanks



This agitated tank is 35 feet high, weighs 10 tons and has a capacity of 17,000 gallons.

The construction is Pfaudler® Glasteel—glass inside, for corrosion resistance; steel outside, for strength. It costs *less* than you would pay for a stainless tank of equal capacity.

You name the size. Admittedly, tanks like this are not standard items. Yet, we can and will deliver Glasteel in vessels sized and designed to fit your needs.

For example, we recently supplied a 7,150-gallon reactor for processing monochloracetic acid and alcohol at 158° F., with jacket designed for 25 psi pressure at 350° F.

Then there are the really big 35,000-gallon Glasteel storage tanks, a very common sight on our production lines.

It takes special skills and facilities in fabrication to make such vessels. We welcome BIG ones. And, again, with Glasteel, big size actually means prices smaller than you pay for many other materials of construction.

Protects purity. The 17,000-gallon tank pictured will be used by The Borden Chemical Company for PVC production. Glasteel has become the *industry standard* for polymerization equipment, since it won't contaminate or discolor any of the materials used or produced. Nor will it act as a catalyst. This equipment is flexible, too, and can be changed from one polymer to another in tune with market trends.

Reduced down time. The surface of Glasteel is abrasion-resistant and smoother than the most highly polished metals. Very little adheres to it. What does you can quickly wash away between batches. Result: more output of product per day than with other materials.

Facts for your files. Bulletin 932 covers Pfaudler Polymerizers. Bulletin 975 details the economies of and specifications for Glasteel Storage. We'd be happy to send copies or answer questions about BIG Glasteel tanks. Write to the address shown on the facing page.

Hardly a "puff" in the (ClO_2) package

"Puffs," frequently caused by rust contamination of sodium chlorate, once were accepted as an inevitable problem in generating chlorine dioxide.

But no longer—not since Pfaudler Glasteel has found increasing use in this field. Take, for example, the complete Pfaudler plant at Gaspesia Sulphite Company Ltd., Chandler, Quebec. On stream since November 1959, this facility has experienced only two "puffs." So noteworthy is this record, that the installation has been dubbed the "puff-less wonder."

The picture shows you part of the equipment that has made this kind of performance possible at Gaspesia—Glasteel primary and secondary generators and stripping column, interconnected with F-C Glasteel pipe. Elsewhere in the plant you'll find scrubber and absorption columns; storage for chlorate, chlorine dioxide, and raw material feeds; centrifugal pumps; and valves—all of Glasteel construction.

What it adds up to is an integrated facility that not only keeps "puffs" down, but also solves all of the severe corrosion problems encountered in the making and storing of chlorine dioxide.

Forty other progressive pulp mills are also making good use of Pfaudler Glasteel equipment. In every case it's shown itself to be the most economical material available in terms of initial cost, maintenance, and service life.

We offer not only equipment, but design, complete engineering, procurement and installation. We would be happy to work with you or your engineering firm on ClO_2 generating systems. Write to the address shown on this page for additional information.

Cut to order . . . F-C Glasteel pipe‡

Immediate delivery is what you can get when you need odd-size lengths of a corrosion-resistant, high-integrity, lined pipe in lengths to 10 feet. That's the availability story on F-C pipe when ordered to size from our factory.

The F-C means "field cut." So you can also do it in your plant with almost any standard dry-abrasive cutoff wheel. Then it's a simple matter of threading, fire-polishing (with a small portable furnace available from us) and finishing with a belt sander. This pipe is rated at 150 psi and comes in 1½, 2 and 3-inch diameters.

‡Patent applied for

Have this new FLUIDICS Buyer's Guide where you can refer to it often

It's set up to give you the range of equipment and services available under the FLUIDICS program from our Pfaudler and Permutit divisions.

From Pfaudler, for example, are the following: corrosioneering, reactions, distillation, evaporation, drying-blending, centrifuging, heat transfer, filling, storage, agitation, valving and piping. Design and engineering services for complete plants or unit operations are also discussed.

The Permutit Division sections cover water treatment, ion exchange, gas analysis and control, flow rate (metering and control), and waste treatment.

In each section you'll find summaries of specifications along with illustrations of the equipment described. Ask for Bulletin 992.

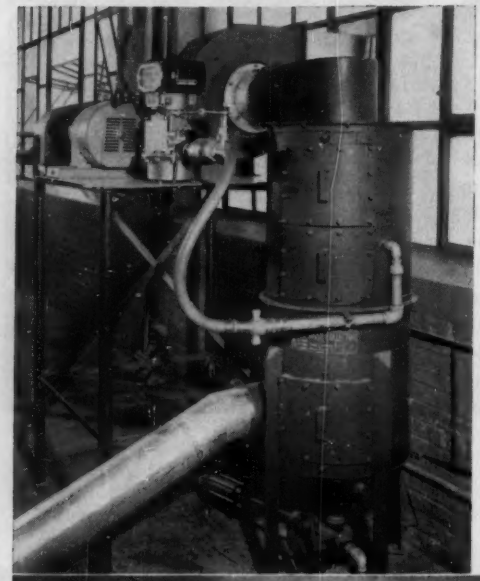
Address all inquiries to our Pfaudler Division, Dept. CE-90, Rochester 3, N. Y.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

MULTI-WASH SCRUBBERS *cover the chemical industry*



There's a MULTI-WASH SCRUBBER to fit your code requirements—handle the air pollution clean-up job with surprising efficiency (up to 99.9%), and with economy too.

MULTI-WASH SCRUBBERS have no equal for simplicity. There are no moving parts, no spray nozzles to clog, and maintenance is held to a minimum. Even the effluent may be reused.

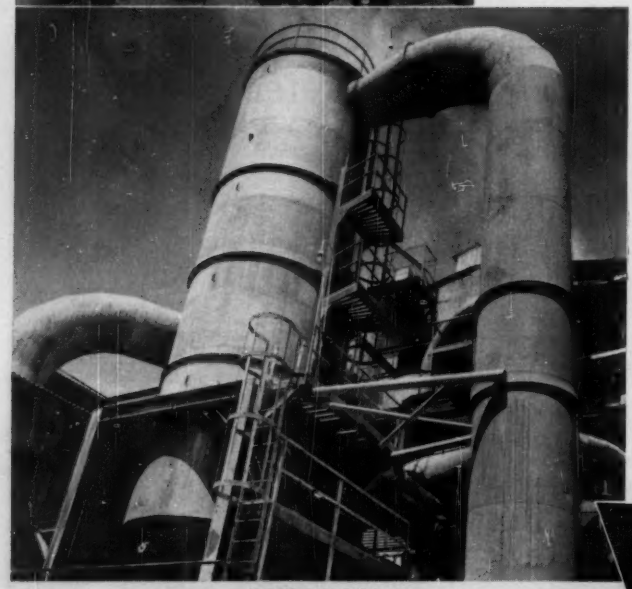
Flexibility is another advantage. MULTI-WASH may be located outside the building, in the roof structure or on the roof itself, to conserve valuable floor space.

In some processes, money-making by-products can be reclaimed with MULTI-WASH.

Scrubbers can be supplied of steel alloys, coated or uncoated, or other special materials to meet all corrosive conditions. Special liquids may also be used for contact.

Handling of collected waste material presents no secondary pollution problem in its wet state.

Get our complete technical data applied to your conditions when you consider an air pollution control system.



APPLICATIONS

- Alumina and Magnesium dusts.
- Borax and Potash—Exhaust from kilns and dryers.
- Explosives—Manufacture
- Fertilizers—Nitrates and phosphates.
- Fisheries—Odors from processing.
- Food—Dusts from process and packaging.
- Glycerine—Fatty acids and phthalic anhydrids.
- Graphite—Grinder dusts.
- Gypsum—Kettle exhaust.
- Kilns—Dusts.
- Organic and inorganic compounds.
- Paints—Pigment dusts and fumes.
- Paper—Sulphuric acid fumes.
- Petroleum—Cracking process odors and smoke.
- Pharmaceuticals—Exhaust from mold dryers, etc.
- Plastics—Dusts from handling and packing.
- Plating—Acid and pickling fumes.
- Quicklime—Cleaning carbon dioxide gases.
- Rayons—Hydrogen sulphides.
- Rubber—Carbon blacks, accelerators, fillers and mixers.
- Starches—Exhaust from dryers and packaging.
- Sugar—Dryer exhaust and reclaiming.
- Tanneries—Buffing and dressing odors.
- Tungsten and Tantalum—Acid fumes, pickling and etching.
- Varnish—Cooking kettle fumes.

PRODUCTS:

Multi-Wash Collectors • Uni-Flo Standard Hoods • Uni-Flo Compensating Hoods • Uni-Flo Fractionating Hoods • Water Curtain Cupola Collectors • Ductwork • Velocitrap • Multi-Dyne Separators • Entrainment Separators • Settling and Dewatering Tanks • Skimmer Type Concentrating Tanks • Pressure Vessels and Storage Tanks

European Licensee: Elex S.A., Zurich, Switzerland

AIR POLLUTION CONTROL **SCHNEIBLE**

See Page in CEC

Refer to Sweet's Plant Engineering File No. 1e/5c

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Top news stories and what they mean to CPI technical decision-makers

Chementator

Taking their cue from steel producers, copper refiners Kennecott and Anaconda are rushing studies of oxygen injection to boost output of copper smelters and reverberatory furnaces.

Minneapolis-Honeywell will be the exclusive manufacturer of Continental Oil's anodic corrosion-control system, trademarked Anotrol (Chementator, Nov. 16, 1959, p. 87). System protects mild steel and steel alloys by forming a passive film electrically on the metals.

Iron chelation raw-material costs can be cut 43% by substituting a mixture of 80 mole % hydroxyacetic acid and 20 mole % citric acid for usual straight citric acid solution, Du Pont finds.

Radical change in aluminum making

Although Aluminium, Ltd., will not reveal any details of its new approach to aluminum production (*Chementator*, Aug, 22, p. 45), a recently issued French patent (1,210,068) discloses the salient features of the new route. Process has excited considerable industry interest because it cuts about in half the capital investment for reduction facilities as well as saving on operating costs. Power requirements, however, are about the same as for the conventional Hall process.

Industry observers believe that in spite of the present aluminum glut a tight market situation will develop within the next 18 months. If the new process, which Aluminium is proving out in an 8,000-ton/yr. plant in Quebec, lives up to expectations, it could greatly reduce the cost of the additional reduction capacity that will be needed.

In Aluminum's process, impure alumina is partially reduced electrically, converting roughly 50% of the aluminum content to metal. The partially reduced mass then contacts $AlCl_3$ vapor at over 1,000 C. and about 1 atm. Under these conditions, the aluminum in the converter reacts with the vapor to form the monohalide, AlCl.

Monohalide vapors then flow to a condenser, leaving behind impurities such as titanium. Vapors cool by coming in contact with a violently agitated pool of molten aluminum; as the temperature drops, the initial reaction reverses, forming $AlCl_3$ and metallic Al. Product aluminum can be tapped continuously from the molten pool while the $AlCl_3$ is recycled to the converter.

Engineers set for crucial union vote

Engineers at nine Sperry Gyroscope Co. plants this week are going to decide for themselves a question that has been debated in professional circles for years: Is trade unionism compatible with professionalism? On Sept. 8, the engineers will vote for or against a newly formed AFL-CIO bargaining unit to represent

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them in wage and working condition talks.

The former Sperry engineering union, Engineers & Scientists Guild, voted to affiliate with the AFL-CIO's International Union of Electrical Workers, following ESG's unsuccessful bid to form a national federation of scientists, engineers and technicians. A dissident group of Sperry engineers, however, successfully petitioned the National Labor Relations Board to hold a decertification vote on the new union. They charge that affiliation with a trade union compromises their professional status. In the upcoming election, all Sperry engineers, not just union members, will be voting.

Earlier, James B. Carey, head of the IUE had hailed the affiliation as "the opening of a new and significant era in relations between professional engineers and trade unions." One inducement Carey offered to the Sperry group was the forming of an Engineering Council in IUE's District Four to preserve the identity of engineering units. Carey also pledged to work for formation of a similar council at the AFL-CIO Industrial Union Dept. level.

Way found to "liquefy" polyethylene

A new family of liquid surface-coating resins will soon be on the market, the result of research by Rene Kales of Delka Research Corp., Glen Rock, N. J. The resins are described only as "liquefied" polyethylene or polypropylene cross-linked with other materials such as urethanes, epoxies, alkyds or vinyls.

Coatings formulated from these resins, plus suitable solvents, dry to a hard plastic surface that can stand temperatures up to 400 F., resist chemicals such as NaOH, toluene, hydrochloric acid, nitric acid and gasoline. Coatings are "one-can" systems, need no curing agent as do epoxies that cause short pot life or require special spray equipment.

Delka will not reveal any of the chemistry behind its new resin formulations. It seems fairly certain, however, that its "liquefaction" process involves controlled oxidation of polyolefin molecules to form shorter, hydroxy-terminated segments. Process creates, in effect, liquid fatty acids or poly alcohols from polyethylene. These reactive hydroxy sites then allow cross-linking with urethanes and epoxies.

Although it is believed this technique is novel in resin production, the Germans used a similar process during World War II to make fatty acids from long-chain hydrocarbons. The petroleum industry has also used airoxidation processes to break down hydrocarbons.

Rubber process does away with crumbs

Major change in the route to synthetic rubbers—or any solvent-based elastomer—is being piloted by the Stamford, Conn., engineering firm of Crawford & Russell. The new method, claimed to substantially lower investment and operating costs, bypasses cumbersome crumb-type coagulation now used.

New process starts with a forced-circulation reactor designed to handle more concentrated elastomer-solvent mixes (20% elastomer vs. usual 5%). Thick, cement-like reactor product is extruded in strings over a 200-F. water bath, is stripped of solvent as the strings join into a thin, continuous sheet. After a second pass under the water to remove last traces of solvent, the sheet is dried in a low-cost air-dryer in less than ten minutes. (Conventional crumb drying time: 2 hr.) Dry sheet is slit, folded, baled for shipment.

Based on pilot operation, C&R claims a 30,000-ton/yr. plant would cost $500,000 less than conventional plants, save ¼-½¢/lb. in operating costs. As an additional benefit, the continuous process yields a clean, nonsticking product, minimizes or eliminates equipment cleanups required in existing plants.

In sight: cheaper beryllium metal

Several companies are hurrying technical and economic studies of Utah's Topaz Mountain ores in hopes of developing this country's first big domestic supply of beryllium ore.

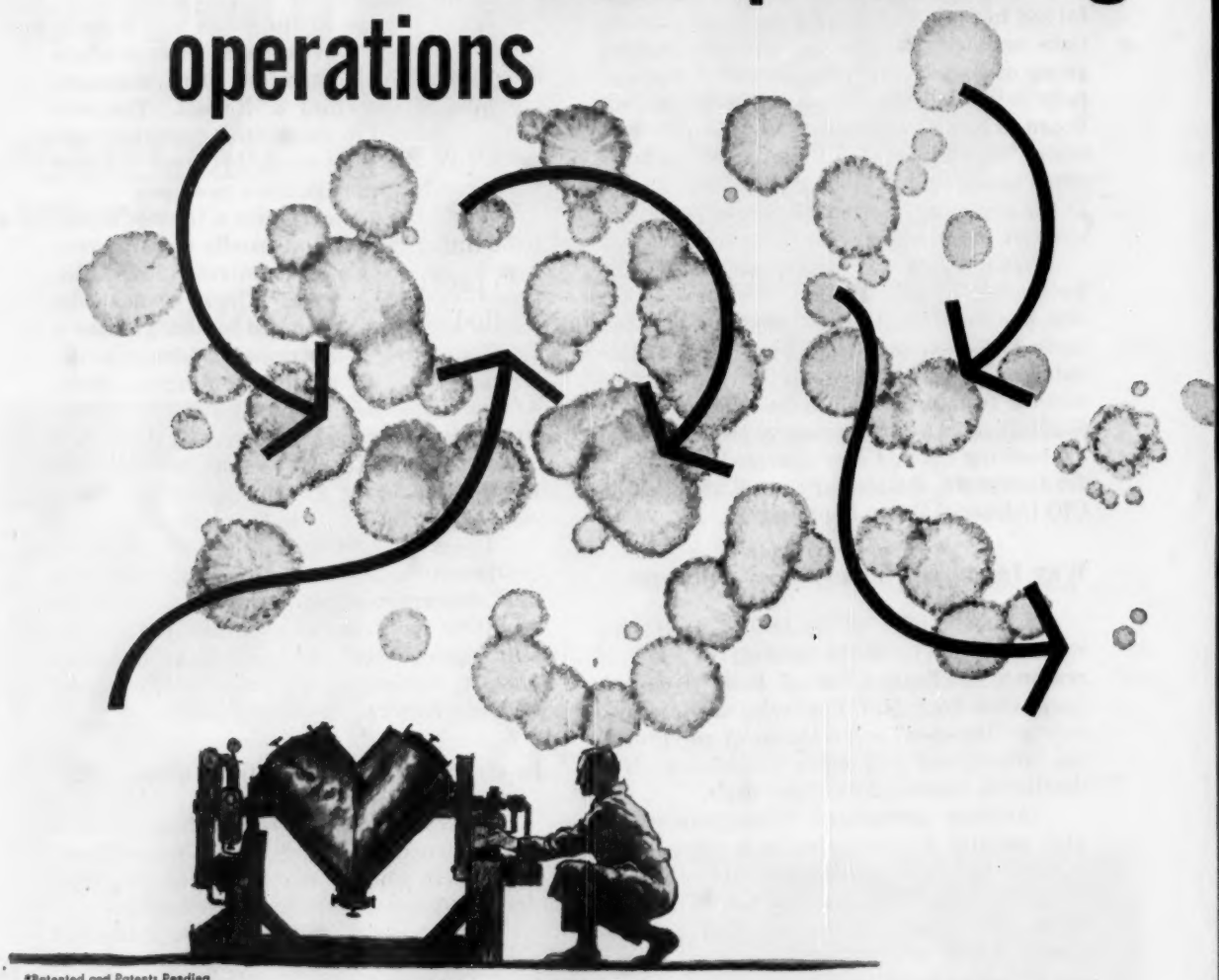
These deposits, still not definitely classified mineralogically, are believed to hold one to three million tons of ore averaging 1% BeO. By contrast, foreign beryl ores, the present source of beryllium, contain only 0.1% BeO as mined. Observers believe that these new deposits can produce beryllium ore concentrate for less than the current price of $36 for each percent of BeO in the ore.

Vitro Minerals Corp. started the excitement several months ago when it announced the Topaz ore's beryllium content can be easily solubilized by acid leaching. Vitro, which now holds leases on over 2,700 acres of ore land, says it has not finished evaluating its holdings. But it believes a beryllium extraction operation

(Continued on page 46)

new P-K solids-processor performs up to*

10 solids processing operations



*Patented and Patents Pending

1. Precision gentle blending
2. Intensive blending
3. Liquid-solids blending
4. Granulation of solids
5. Vacuum drying of solids
6. Coating of solids
7. Heat sterilization of solids
8. Gas sterilization of solids
9. Chemical reaction of solids
10. Heating or cooling of solids

(Many of these operations can be performed under vacuum)

The P-K Solids Processor gives you many exclusive opportunities for savings — in *quality control, equipment, time, manpower, space.* It not only combines vacuum drying and liquid-solids blending in one fully packaged unit for the first time, but it also performs in a simple sequence more operations in a single unit than ever before possible.

DRY BLENDING— With this latest P-K "Twin-Shell" development you can tumble solids to give gentle precision blending. This may be done under vacuum or atmospheric conditions, in inert or sterilizing gas, with heat in jacket up 200°F., or with cooling through jacketed shell. If required, intensifier bar action breaks up agglomerates or gives uniform dispersion of difficult materials such as pigments.

LIQUID DISPERSION, GRANULATING — You can disperse controlled amounts of liquid uniformly into solids. Fluids of any viscosity can be handled.

Dispersion can be sufficiently intimate to provide a lump-free powder. Or you can regulate it to produce granulations of controlled size. As in dry blending, you can conduct these steps under vacuum or atmospheric conditions, in inert or sterilizing gas, or with cooling or heating through jacketed shell.

VACUUM DRYING— You can use the P-K Solids-Processor to vacuum dry heat sensitive materials. A separately actuated agitator speeds drying to a finished fine powder or controlled granule. In final stages of drying, direct hot air or gas can be introduced.

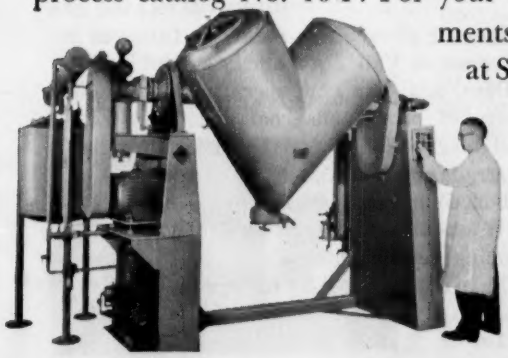
All P-K Solids-Processor systems are completely packaged. Available in standardized models with charge capacities from one to fifty cubic feet.

PRE-TEST SERVICES — A production model of the new Solids-Processor is available for pre-testing at our Pre-Test Laboratory in East Stroudsburg. Standard, intensifier and liquid-solids "Twin-Shell" Blenders are also available . . . as are packaged vacuum tumble dryers (conical type) and ribbon blenders.

Using your materials, P-K engineers can demonstrate things impossible to see without pilot study . . . work out subtle variables in blending, granulating, drying . . . indicate scale-up results and operational procedures . . . and predict savings in materials, labor, investment.

You'll gain the most by making the trip personally to East Stroudsburg. Your guidance will be helpful. If you cannot make the trip, send your materials.

All P-K equipment is completely described in P-K's new process catalog No. 16-P. For your copy or to make pre-test arrangements, write or phone George Sweitzer at Stroudsburg, Hamilton 1-7500.



Patterson Kelley

Chemical and Process Equipment Division
112 Burson Street, East Stroudsburg, Pa.

is feasible from a technical standpoint.

Another firm, Beryllium Resources, Inc., working with Brush Beryllium, claims it has the first practical process for retrieving beryllium from the new ores. The company starts with a unique two-stage flotation to upgrade the ore to 10% BeO; first step removes the lime-silica tuff, the second removes associated fluorine compounds. Beryllium recovery is about 90%.

Beryllium concentrate is then leached with sulfuric acid. Solution obtained is more complex than that produced from beryl ores because more of the gangue dissolves, introducing fluorine, manganese, iron and potassium salts. Beryllium Resources recovers Be values from the solution by an undisclosed multistep process.

Several other companies have been active in securing mineral rights in the Topaz Mountain area including Du Pont, Food Machinery and Combined Metals Reduction. Beryllium Resources, Inc., recently became the second largest land holder when it snapped up 2,700 acres.

Rocket fuel via fissio-chemistry

Hard on the heels of the official signing of a $25-million contract between the Air Force and Olin Mathieson for supplying hydrazine fuel for the Titan II missile, comes word of a new process that may cut the cost of hydrazine to as little as one-fourth of its present level.

Aerojet-General Nucleonics, which has proposed making nitric acid via radiation (*Chementator*, May 30, p. 40), now believes it has a much more economically attractive process in the conversion of liquid anhydrous ammonia to hydrazine (NH_2NH_2). Unofficial estimates indicate that present price of hydrazine could probably be cut from $2.12 lb. to less than 50¢/lb.

Aerojet proposes using a system in which uranium dioxide is in direct contact with the ammonia. Reactor would operate at moderate temperature and sufficient pressure to keep the ammonia liquefied. Liquid phase reaction is better than gas phase, AGN feels, because higher molecular density will give higher utilization of fission fragments and higher production rates.

Fissio-chemical reaction might be able to compete successfully in this area because hydrazine is a high-priced chemical and because present processes are relatively inefficient. Current ammonia-caustic-chlorine route produces a product solution with only 0.5% hydrazine, requires several complex extraction steps.

Preliminary estimates indicate a 25-million-lb./yr. fissio-chemical hydrazine plant would cost about $22 million. But process is still in the paper stage, Aerojet emphasizes, and will take four to five years to bring to commercial realization.

Foamed styrene woos paper's market

Several companies, almost simultaneously, have come out with polystyrene foam films that are expected to compete with paper in many applications. Selling for about $4-10/1,000 sq. ft., the foam film looks and feels like kidskin, is waterproof, grease resistant and insulating.

Among the markets envisioned for the new film are disposable plates, insulating laminates, food packaging and printed wrappers. Although these films are only developmental now, producers believe they will soon soak up a significant amount of styrene output.

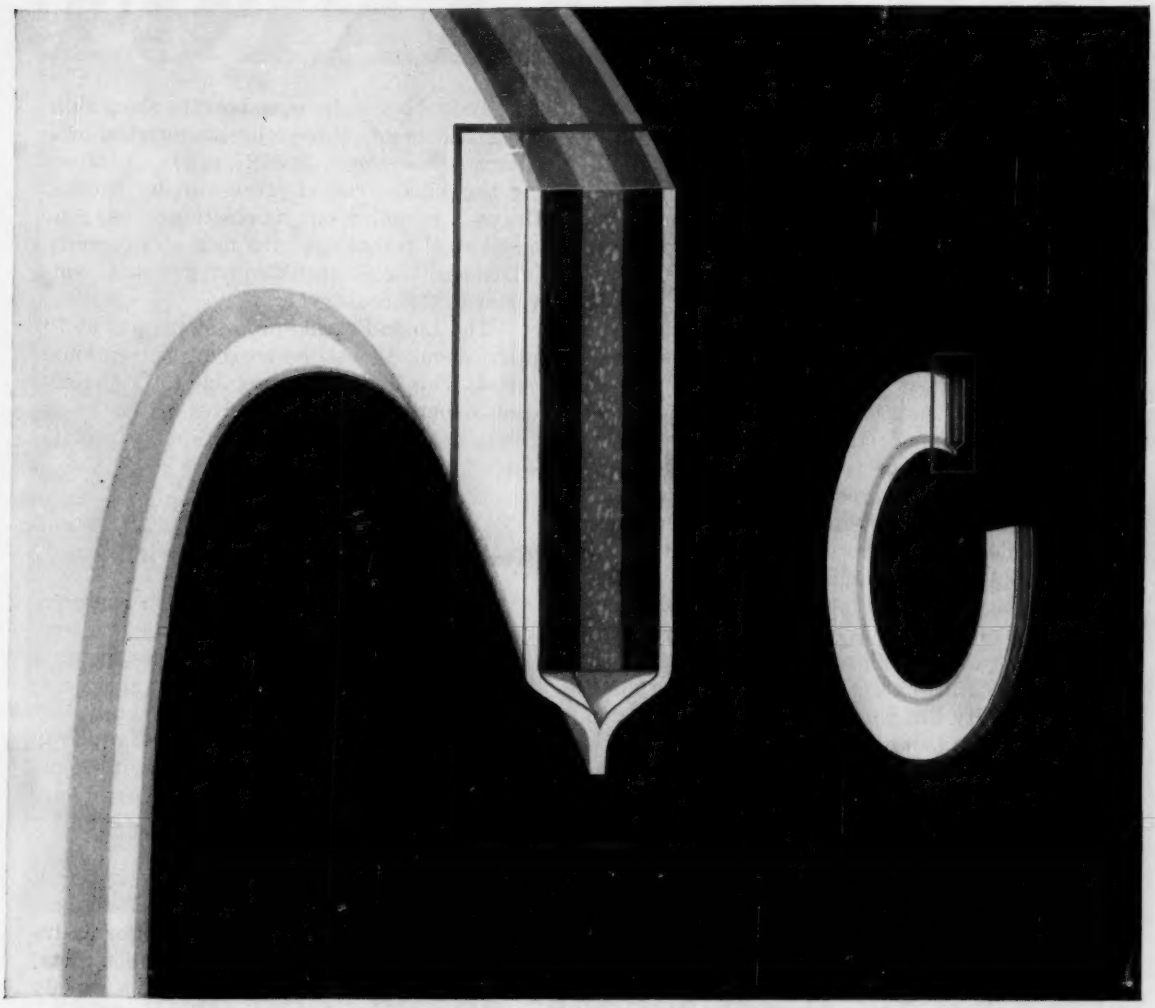
Koppers Co. has received several patents covering blow-forming and additive systems for the new foam films and has licensed three producers: Dyna-Foam Corp., Ellenville, N. Y.; Gilman Bros., Gilman, Conn.; Applied Research Corp., Chippewa Falls, Wis. Koppers says it has no plans to produce the film itself; its main objective is to provide a new outlet for its Dylite expandable styrene beads.

Another styrene producer, Monsanto Chemical, is taking the opposite approach. Firm will market its own line of styrene foam film under the trade name Santofome, in thicknesses ranging from 0.01 to 0.03 in. Dyna-Foam has already announced availability of foam film 0.006 to 0.1 in. thick and up to 60 in. wide.

Can coal win role as reducing agent?

Electric phosphorus-reduction furnaces at the Tennessee Valley Authority's plant at Wilson Dam, Ala., are now operating on a 50-50 mixture of bituminous coal and coke. Estimated yearly saving over the cost of metallurgical-grade coke: $175,000.

When coke alone is used for reducing carbon, it accounts for about 12% of the cost of producing phosphorus. Producers have long sought to cut this cost by using coal. But they have been stymied by the volatile matter in the



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Here's the gasket that can scoff at active chemicals and solvents. That's because the envelope-type design combines the protection of both compressed asbestos filler and Du Pont Teflon.

A center core of compressed Chrysotile Asbestos is sandwiched between two layers of felted Blue Asbestos. These three asbestos layers provide longer life . . . outstanding corrosion and heat resistance . . . and the "cushion" effect so desirable in glass-lined equipment. A split or welded envelope of electrical-grade Teflon is then added for even greater corrosion resistance.

Chempac Gaskets are soft, conformable and effect a seal at low bolting. Available in pipe sizes from ½" to 12" as standard. Other J-M envelope-type gaskets are also available in various sizes and with special fillers for specific requirements.

It will pay you to solve your corrosive sealing problems with Chempac Gaskets—*especially designed* for that purpose. You can rely on them to give you the most effective sealing . . . and longest, most economical service per dollar invested. See your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ont. Ask for Chempac Book, PK-124 A.

JOHNS-MANVILLE

coal that carries over into the phosphorus and imparts a dark color. Western phosphorus producers in particular would like to use native coal reserves because their coke must be shipped from the East. Several firms are now exploring processes for upgrading western coal reserves into metallurgical-grade coke (*Chementator*, Jan. 25, p. 43).

A TVA spokesman says that it has also encountered some color problem from the coke-coal mixture, but that it is "under control." Another consideration is that the TVA phosphorus goes into fertilizer, while most of the furnace phosphorus produced in this country goes into chemical production. Fertilizer end-uses can tolerate slightly discolored phosphorus while chemical processes usually cannot.

TVA emphasizes, however, that its research in this area is far from complete. Other factors to be studied: (1) use of higher coal-to-coke ratios; (2) use of cheaper coals with higher volatile content (TVA is currently using high-quality bituminous); (3) decolorizing to produce a standard-grade product.

Oxygen keeps steel revolution simmering

Firmly entrenched in open-hearth and basic-oxygen steel operations, oxygen makers are turning their attention to the blast furnace. Object: to increase production as much as 30% from existing facilities through use of fuel injection and oxygen enrichment. Besides postponing the need for building additional capacity, raising blast furnace productivity could also take away some of the attractiveness of the direct-reduction routes now under study.

To predict how blast furnace operation can be improved without costly in-plant testing, Linde Co. has developed a generalized mathematical model of blast furnaces, which can be fed to a computer along with data from the unit under study. Predicted results agree with 4% of actual operation.

Experiments on small furnaces show that besides the increase in production, use of oxygen and fuel injection can decrease coke rate about 25% and boost calorific value of the top gas to 100-115 Btu./cu. ft. Studies show that coke-oven gas and fuel oil injection provide high production rates but are less effective in saving coke than is natural gas.

In another development, Dravo Corp., Pittsburgh, Pa., will build a 290-ton/day German Linde-Fraenkl oxygen plant for Ford Motor Co. at Dearborn, Mich. Ford is pioneering oxy-fuel lances for open hearths along with Air Products and three other major steel producers (*Chementator*, June 27, p. 60). By offering the Linde-Fraenkl process under license, Dravo is rounding out its position in oxygen-based steel technology; the firm also recently introduced the Stora-Kaldo oxygen steel converter to this country.

The Linde-Fraenkl process operates at 70 psig., about 15 psi. lower than conventional cycles. This lower pressure, due to "superefficient expansion turbines," gives 8-10% lower power consumption, which cuts oxygen costs 4-5%.

Research and development briefs

Polypropylene process variation has been developed by Tokuyama Soda, Japanese chemical manufacturer. Using a Natta-type catalyst system, Tokuyama introduces a spark discharge "to enhance the effect of the catalysts." Several Japanese firms are now negotiating for foreign polypropylene licenses, but if Tokuyama's patent claims are upheld, it could further cloud an already hazy patent situation.

Molten metals chill at a rate of 2 million deg. F./sec. in a device called a "splat-cooler." In the process, developed at the California Institute of Technology, droplets of hot metal are shot against the copper rim of a rapidly spinning wheel, which is cooled to —300 F. by liquid nitrogen. Metals flatten into thin foil platelets, about ½ in. square.

Acrolein from propylene via a new catalytic route is being piloted by Standard Oil of Ohio. Using a special bismuth-phosphorus-molybdenum catalyst, process is claimed to make acrolein at substantially lower costs than other methods. Catalyst is only one-fifth as expensive as those in commercial use, says Sohio.

Uranium carbide-plutonium carbide nuclear fuel elements may give higher fuel burnup, improving atomic power economics. Carborundum Co., Niagara Falls, N. Y., is researching synthesis and fabrication of these new materials. The carbides are more refractory than the metals, permitting higher reactor temperatures. Too, the carbides distort less as fission products are generated, allowing longer operating life before reprocessing is needed.

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New expanded polystyrene case offers advantages never before found in "C.P." Acid containers!

Lighter! Stronger! Safer! Exclusive new expanded polystyrene case for B&A® "C. P." Acids!

An exclusive development of General Chemical, this new "one-way" case holds four 5-pint "C.P." acid bottles in contoured pockets formed of shock-resistant low density expanded polystyrene. Here is still another packaging "break-through" from America's leading producer of laboratory and scientific chemicals . . . another example of continuing B&A leadership in reagent packaging.

Smaller! Lighter! The new case is substantially smaller than old-fashioned containers and is far easier to store and handle. Tare weight with empty bottles is less than 1.1 pounds. This saves you money on freight.

Easier to handle! Convenient finger grips make case easy to lift and carry. Top and bottom specially designed with interlocking feature for safe stacking.

Safer! The new polystyrene case is chemically resistant, and it is weather-resistant, too. Withstands outdoor storage. Bottles are "cradle cushioned," fully protected in form-fitted polystyrene pockets.

Stronger! The new case is far stronger than other "one-way" cases now in use for "C.P." acids. In thorough and extensive testing, it has met the most stringent ICC drop test requirements . . . bottles remained unharmed after 16 separate drops from a 4-foot height!

Order Now! These new units are now ready for shipment from General Chemical's B&A distributing points coast to coast. They have had more than a year of intensive research and testing and are *proved* superior to any other type of "shipper" now available! For further information, phone or write your nearest B&A office.

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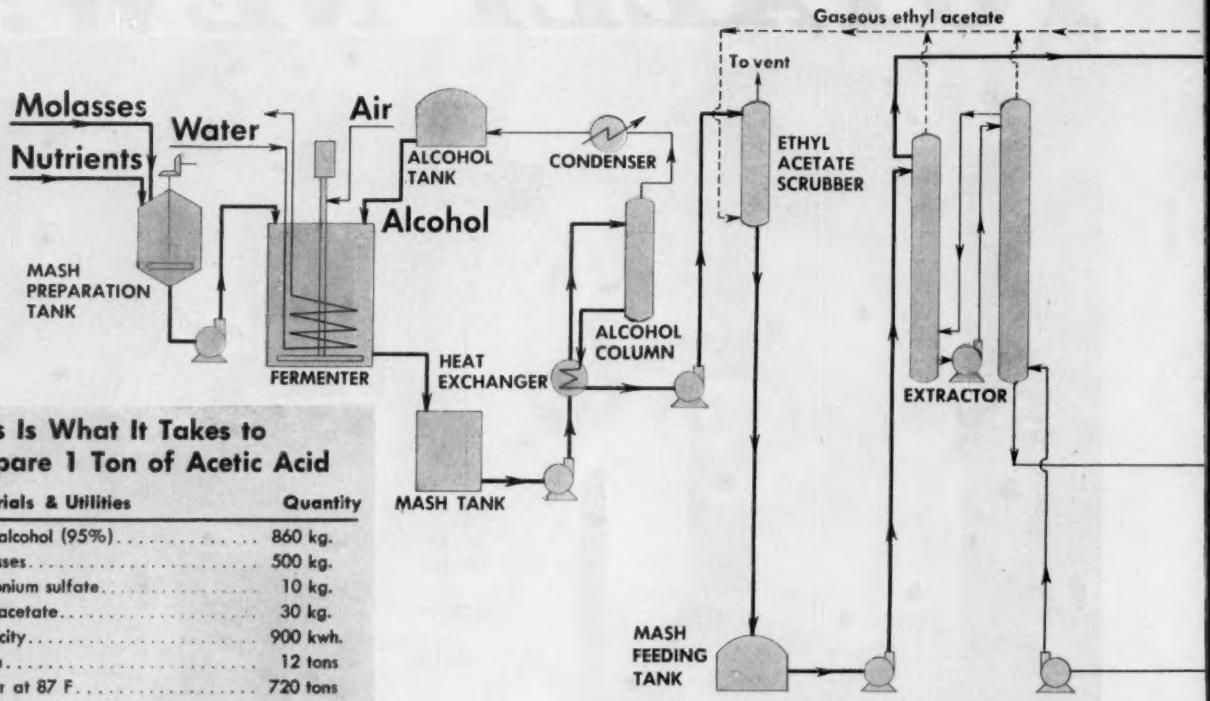


This Is What It Takes to Prepare 1 Ton of Acetic Acid

Materials & Utilities	Quantity
Ethyl alcohol (95%)	860 kg.
Molasses	500 kg.
Ammonium sulfate	10 kg.
Ethyl acetate	30 kg.
Electricity	900 kwh.
Steam	12 tons
Water at 87 F	720 tons

Acetic Acid by Submerged Fermentation

Cheap molasses and alcohol, new bacterial strain, liquid-liquid extraction enable Formosan plant to turn out high-purity product at low cost.

Application of submerged fermentation to the production of glacial acetic acid from alcohol and molasses has enabled Chiayi Solvent Works, Chia-Yi, Taiwan, to:

- Cut fermentation time.
- Increase acid content of the mash.
- Obtain higher efficiency and greater purity.

One of three 1-2-ton/day plants built in the Far East in 1959 (two in Taiwan, one in the Philippines), the Chiayi facility was placed on stream last December. Following several years of lab work and more than two years in the pilot plant to obtain necessary production data, the new plant has already demonstrated the practicability of the process.

Company is already expanding its facilities, and expects to double plant output by end of the year.

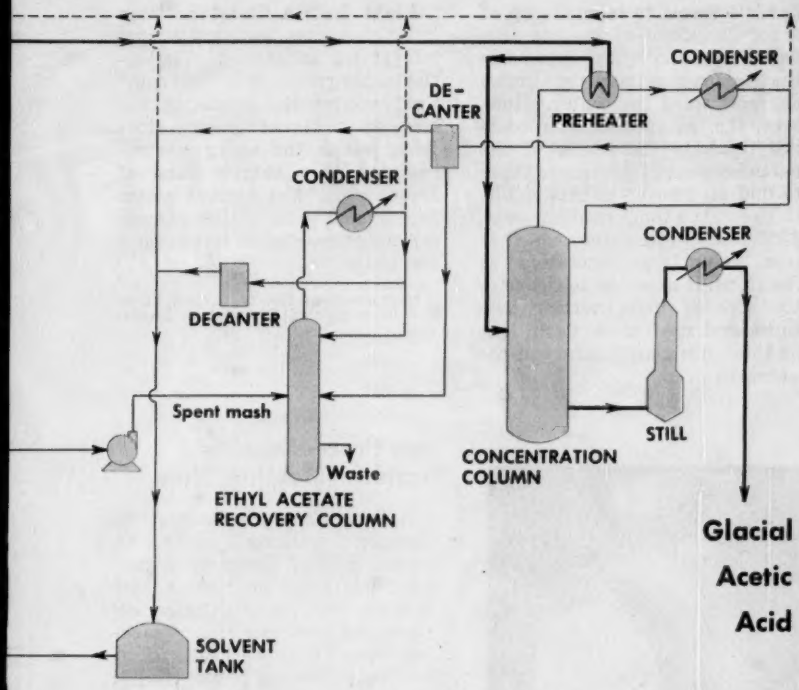
An over-all efficiency exceeding 90% of theoretical has been regularly obtained, with production costs comparable to the synthetic process.

▶**New Twist to Old Process**—Production of acetic acid or vinegar by fermentation is an ancient process. It is probable, however, that no commercial glacial acetic acid was previously made by this method because of its relatively high cost.

But with development of submerged cultural fermentation, the situation has changed. In combination with liquid-liquid extraction, production of glacial acetic acid by the fermentation method is now practical and economical in countries where cheap molasses or ethyl alcohol are available. (Price of 95% ethyl alcohol in Taiwan is 30¢/gal. vs. a price of 56¢/gal. in this country.)

▶**Special Strain of Bacteria**—Process starts when a mash containing 1-2% ethyl alcohol, 1-2% molasses, and nitrogen-containing nutrients is inoculated with a special strain of acetic acid bacetria (*Acetobacter*).

This bacteria was isolated and identified in the company's laboratory as a new species *Aceto-*



bacter No. 4601. It is said to be active over a wide temperature range (83-105 F.), an important consideration in a country like Taiwan where cooling water temperature is usually high. This strain of bacteria produces up to 11% acid on the mash, and gives a fermentation efficiency of about 95%.

The mash is agitated and aerated for 48-60 hr. until acetic acid content is approximately 10%. Alcohol content of mash is maintained at 1-2% during fermentation by regular additions of 95% alcohol. (Greater alcohol content would lead to high losses through evaporation.) These additions are stopped during last stages of the fermentation, causing the alcohol content to drop to less than 0.5%.

When acid content reaches 10%, mash is removed from fermenter and extracted with a solvent, preferably ethyl acetate. Continuous countercurrent extraction is employed, with a 2:1 ratio of solvent to mash. Spent mash leaving extractor contains 0.1-0.2% acid. Extraction efficiency is around 98-99%.

Extract is fed to a concentration column where solvent and water are distilled azeotropically overhead and the acetic acid is concentrated and withdrawn from the bottom. It is redistilled to obtain glacial acetic acid.

▶ **Conventional Equipment Used**—A standard fermenter equipped with 120-150 rpm. agitator has been found satisfactory for the process. Air is introduced into hollow shaft of agitator and distributed through holes in the impellers. Cooling coils inside fermenter remove excess heat of fermentation. When molasses is used, a foam breaker should be provided.

Acid is extracted from mash in two 40-ft.-high packed columns connected in series. However, triple-stage centrifugal units may be used. Solvent is recovered in a packed stripping column. And a bubble-cap plate column containing 40 plates is used to concentrate the acid.

▶ **Materials of Construction**—Wood is satisfactory for fermenters, mash receivers and

continues on page 52

New Binder Gives Solid Rocket Fuels Big Boost

That long-sought goal of missile men—the million-lb.-thrust, solid-fuel rocket—is a lot closer today as a result of a new solid-fuel binder developed by North American Aviation's Rocketdyne Div. at McGregor, Tex. The binder is a carboxy-terminated linear polybutadiene, which will probably supplant the present favorite, polybutadiene-acrylic acid copolymer (PBAA). The new binder is being incorporated into a new family of propellants called Flexadyne.

One of the big problems hindering development of bigger solid-fuel rockets has been the lack of reproducibility of fuel performance as the motors get bigger. With fuels made with PBAA, for example, each new lot has to be turned into test propellants, first to determine the optimum curing time and, second, whether the cured fuel is satisfactory. Rocketdyne attributes this erratic behavior to random molecular structure in the binder.

Secret of success of the new Flexadyne fuels is the careful tailoring of the binder polymer through special synthesis control, so that each molecule is symmetrical and approximately the same length. Besides the desired reproducibility, the new propellants will not crack or tear, have sufficient stretch to survive the shock of firings. And they will not sag during long periods of storage.

Both Flexadyne and PBAA propellants have well-balanced properties, including essentially constant elongation over the temperature range −75 to 175 F. At any given temperature or solids loading, however, Flexadyne has about twice the elongation of the corresponding PBAA formulation, giving a mechanically tougher fuel.

Rocketdyne is currently studying the possible tie-in of electronic control equipment with continuous propellant processing. Improved control of such a system would increase the uniformity of fuel composition, substantially improve fuel reproducibility, as well as allow instantaneous detection of process upsets.

tanks that hold dilute acid. But cooling coils, agitators and other units in fermenters should be of stainless steel to eliminate the threat of corrosion.

Hot concentrated acid in absence of air does not attack copper, hence the extraction column, stripping column and concentration column may be made of this metal. Either copper or stainless is recommended for pipes and fittings.

Aluminum bronze may be used for pumps handling dilute acid, but for concentrated acid, Duriron or stainless should be used. For low-temperature dilute acid transportation, pipes and fittings of molded polyvinyl chloride or its copolymers have been found satisfactory. However, stainless steel should be used in equipment for handling the end product to protect the final purity.

High-purity aluminum is resistant to concentrated acetic acid. It may be used in storage tanks or vessels, as well as for pipelines.

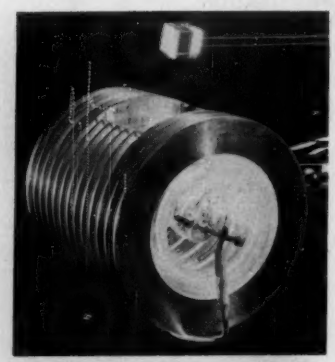
Spectrometer Looks Into The Heart of Matter

In an attempt to solve a mystery that they themselves created, scientists at Stanford's High Energy Physics Laboratory have unveiled a giant magnetic spectrometer with which they hope to probe into the core of nuclear particles.

The trouble started three years ago when this same Stanford group, headed by Dr. Robert Hofstadter, made precise measurements of the fundamental nuclear particles, the proton and the neutron. They discovered both particles to be equal in magnetic size but not in electrical size (the neutron's charge size is much smaller than the proton's). These findings run counter to present electromagnetic theories, which have assumed that the neutron has a corresponding charge size.

With his old equipment, Dr. Hofstadter started probing the particles themselves to see if he could find the reason for this anomaly. He found that each particle seems to be made up of a fog-like cloud of mesons (believed to be the "glue" that holds the nucleus together) that grows denser toward the center. However, the old spectrometer could not reach to the center of the particles where Hofstadter hopes to find an answer to this riddle.

The 150-ton, million-watt, $500,000 spectrometer, which is just going into operation at Stanford, is expected to cleave to the core of these nuclear particles and shed some more light on the fundamental nature of the atom.



Light Amplifier Heralds New Communications Era

True amplification of light, a goal occupying many scientists throughout the world, has been achieved by researchers at the Hughes Aircraft Co. with a device called a "laser."* Starting with ordinary light, the laser produces a coherent (single frequency) light beam, said to be brighter than the center of the sun.

Hughes' discovery is hailed as a major scientific achievement because it extends man's ability to generate electromagnetic frequencies from the microwave range of about 50,000 million cycles up into the 500,000-billion-cycle range. As well as being valuable for physical experiments, the laser may find practical application in space communications, in raising the number of broadcasting channels on earth, and in medical and photochemical uses.

Here is a brief description of how the laser amplifier works:

Light from a flash-tube lamp irradiates a synthetic ruby crystal (at top in photo). The optical energy of this "random" light excites the atoms in the ruby to a higher energy state from which the energy is reradiated in a narrow band of frequencies. The excited atoms are coupled to an optical resonator and stimulated to jointly emit the radiation.

*An acronym for Light Amplification by Simulated Emission of Radiation.

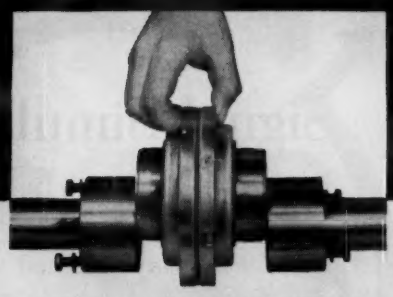
New Process Slashes Graphite Molding Time

Armour Research Foundation, Chicago, working under an Atomic Energy Commission contract has come up with a new process that substantially reduces the time and cost of making molded graphite. Because of its high thermal conductivity, low neutron absorption and other desirable properties, graphite is finding increasing application as a moderator in new nuclear reactor designs.

In the conventional graphite manufacturing process, a carbonaceous material such as petroleum coke is mixed with a binder such as coal tar pitch. The mixture is then molded and carbonized at 2,700 F. to eliminate the volatile materials. After cooling, the resulting carbon is reheated to approximately 5,000 F., which causes it to crystallize into graphite.

In the new Armour process, carbonization and crystallization steps are combined into a single heating and cooling cycle. Key is a synthetic binder, furfuryl alcohol, which is combined with petroleum coke and heated directly to graphitization temperature of 5,000 F. without intermediate cooling. Carbonization takes place during the early stages of heating.

Process is possible because furfuryl alcohol is a thermosetting material, hardening when heated. Parts fabricated with the new synthetic binder do not require support during carbonizing, as does a body made with conventional binders.



*FALK and STEELFLEX are Registered Trademarks

Cut disconnect-reconnect time by as much as 50%

The FALK Spacer Coupling is specially designed for quick installation or removal *without disturbing the driving or driven unit.* This feature can save you up to 50% in disconnect-reconnect time when critical equipment—a process pump, for example—needs repair or replacement.

Here's another saving: with the FALK Spacer Coupling, you can quickly realign shafts *without the usual loss of operating temperature!*

And still another: you can remove or reinstall the FALK Spacer as a unit *without draining the lubricant.*

Because of its exclusive grid-groove Steelflex design, the FALK Spacer can accommodate residual misalignment—parallel, angular, or (most important) *both.* Also, it provides torsional resiliency that cushions shock and vibration. Thus it saves wear-and-tear on your connected equipment.

To prove these claims and enjoy these savings, install a FALK Spacer on one application—and see for yourself. Consult your FALK Representative or Authorized Distributor.

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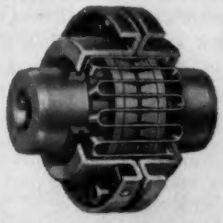
Representatives and Distributors in many principal cities.

EASY AND QUICK TO INSTALL, DISCONNECT OR RECONNECT

First, mount shaft hubs to allow proper distance between hubs; then, align driving and driven units.

Second, compress Spacer to fit space between hubs and tighten cap screws to pull spacer hubs into the registered fit.

To disconnect, reverse the second step. No draining of lubricant necessary.



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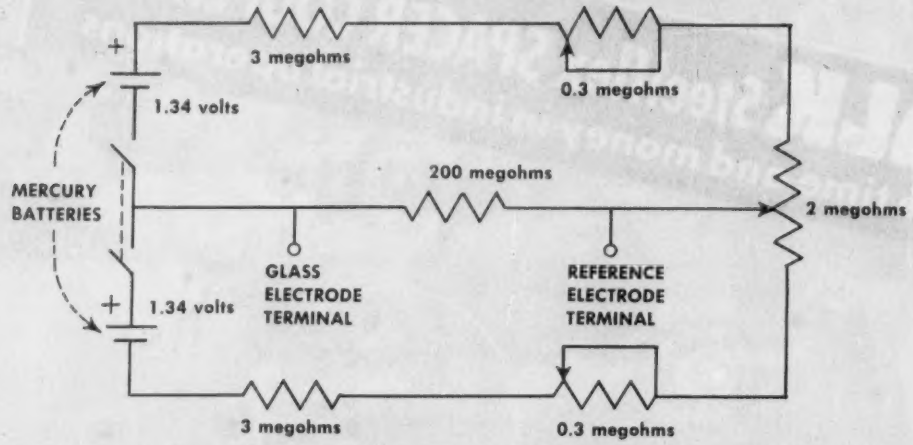
Circuit Diagram for pH Potential Simulator



Signal Simulator Speeds Maintenance

Company-designed unit that monitors pH electrode assemblies in effluent treating system pinpoints trouble source for double-quick repair.

All it took to overcome a sticky maintenance problem in the pH control systems of the effluent treater at Shell Chemical Co., Houston, Tex., was a company-designed signal simulator.

Permanently mounted behind panel board in control room of treater, which has pH electrode assemblies in its primary and secondary neutralizers, flotation tank and outfall line, the simulator has:

- Facilitated checking operation of the pH systems.
- Saved time formerly spent by maintenance personnel in isolating malfunctioning parts.
- Increased life of pH cells, which were previously disposed of while still serviceable.

▶ **Control Posed Problems**—The treater, placed on stream in July 1958, was designed to discharge an effluent of controlled pH suitable for reuse in some processing operation. Satisfactory performance of this following process depends on closely controlled pH.

But experience with the system showed the need for an instrument to quickly locate origin of malfunctions. Considerable maintenance time was being spent isolating the source of pH system trouble to either the amplifier or the electrode system.

For this reason, a study was initiated with the object of improving the reliability of the pH systems and reducing the high maintenance costs associated with them.

▶ **Effluent System Highlights**—Waste enters the treater from two large chemical sewers. It passes through a pair of stationary bar screens (which catch large pieces of trash) before entering the primary neutralizer. Then, in sequence, it moves through (1) an API basin; (2) secondary neutralizer; (3) roughing clarifier; (4) chemical treating units, and (5) air flotation units.

Primary neutralizer is equipped with two pH electrode assemblies that are connected to a recorder-controller through a manual selector switch. This recorder-controller operates motor valves that permit spent soda to flow, as needed, to the primary neutralizer to satisfy demand for alkali during an acid spill.

An electric mixer provides uniform mixing of the spent soda with the waste stream before the latter is discharged into the API basin.

In the latter, light materials rise to the surface and are skimmed off. Heavy solids sink to the bottom and are pumped to a sludge pit. The partly clarified effluent flows into the secondary neutralizer, which is divided into a number of sections, each provided with air agitation.

This large tank was provided to slow rate of change of pH so that the recorder-controller, connected with the electrode as-

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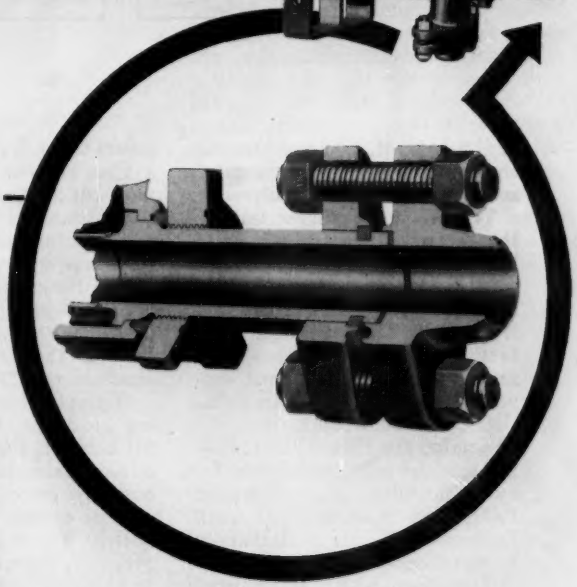
Type O Low Pressure Heat Exchangers



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- **TWO STUD FLANGES:** Greatly simplifies installation and maintenance over multi-stud fixed or lap joint type flanges.
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- **ALL CONNECTING FLANGES FURNISHED:** A savings well worth evaluation!
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- **MISALIGNMENT IMPOSSIBLE:** Shell nozzle inlet and outlet are precision machined, integral units.
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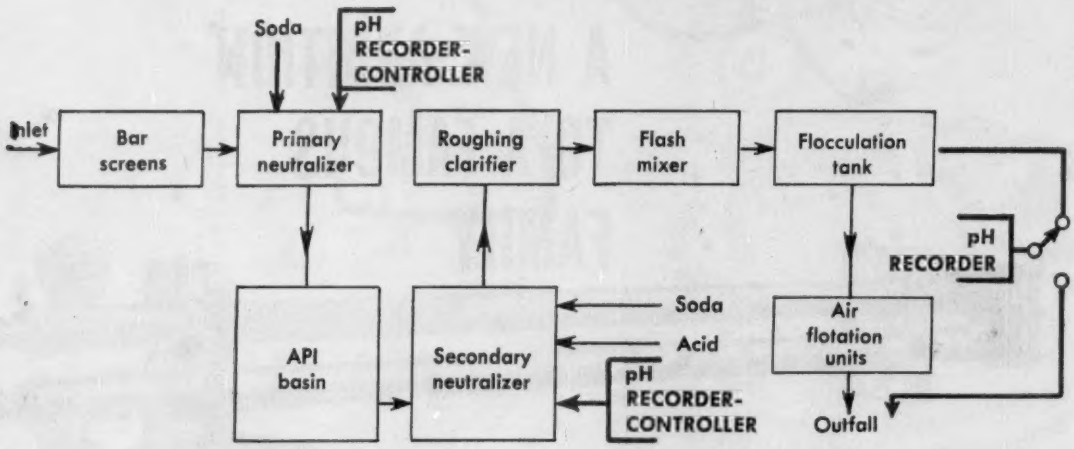
SYMBOL OF EFFICIENCY IN HEAT TRANSFER PRODUCTS

Closed-Loop Control Gives Tight pH Regulation in Water Plant



semblies in it, could sense the changes and operate a series of acid and caustic motor valves.

The pH of the effluent leaving the secondary neutralizer must be maintained at 8 ±0.5 to obtain good flocculation in latter stages of the treating process. Without close pH control, a satisfactory floc cannot be developed, and a carry-over of oil and suspended solids from the air flotation units could result.

▶**Forming the Floc**—The roughing clarifier was provided to remove floatable oils, suspended solids, and to smooth out small fluctuations in pH. It discharges to the chemical treating unit.

This tank, which is equipped with an electric mixer, was installed to provide rapid dispersion of the chemical flocculating agent. The chemical is added through a pulsed control valve.

The flocculation tank, next unit in the system, provides a means of agglomeration and adsorption of the suspended solids and emulsified oils on the surface of a chemical floc so they may be removed in the air flotation units.

▶**Simulator Details**—The signal simulator is primarily a millivolt generator with a high initial resistance, utilizing a voltage divider network to give positive and negative output voltages. Signal output can be set at any value from ±295 mv., which covers the potential generated by a glass-reference electrode pair from pH 2-12 at 77 F.

Calibrator is connected to the amplifier instead of the glass and reference electrodes. When used with a Beckman Model W industrial pH amplifier, a 2,900-ohm precision resistor is substituted for the thermo-compensator to simulate the 77-F. solution.

If amplifier is in proper working condition, it will read any pH between 2 and 12 that is set on signal simulator. In this manner any inaccuracies, sluggishness or erratic operation can be noted. If amplifier functions properly, source of trouble lies in electrode system.

Common means of correcting for temperature effect on millivolt potentials is by use of a third electrode, which is temperature sensitive, in the pH electrode assembly. These units were initially installed at the effluent treater. However, they added considerably to the cost of the assembly, as well as presenting an additional maintenance problem.

During the study, it was noted that temperature of effluent varied only 15 deg. F. throughout the year. This variation introduced a maximum error of less than 0.1 pH unit, which was not sufficient to warrant the expense of the thermo-compensators. So these units were removed and precision resistors substituted for them in the amplifiers.

▶**Electrode Assemblies Moved**—To eliminate time lag frequently encountered in continuous sample methods, all of the electrode assemblies in the effluent treater were immersed directly in the liquid. But the electrodes soon became coated with oily materials that concentrate near the surface, thus creating a major problem.

Experiments indicated that the coating was lessened by submerging the electrodes to a depth of 3-4 ft. This meant abandoning the immersion reference electrodes which become pressured due to the hydrostatic head at this depth. So these were replaced with side-arm reference electrodes. The side-arm units permitted attachment of tubing that terminated at bottom of the reservoir bottle located above the level of the effluent stream.

This arrangement permitted filling the bottle and tubing with KCl solution so that a hydrostatic head of filling solution was always exerted against junction of electrode and possibility of effluent back-up was eliminated.

Simulator was constructed at a cost of $200, the major expenditure being for the pH adjustment potentiometer.

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THE ALLEN-BRADLEY LINE of BULLETIN 700 RELAYS IS COMPLETE!

TYPE B general purpose relay shown with 2 N.O. and 2 N.C. contacts. Made with up to 8 poles in various arrangements.

TYPE BX universal relay shown with 4 poles having both N.O. and N.C. contacts. Additional contacts on the 6 and 8 pole relays are N.O. only.

THESE IMPROVEMENTS ARE *IMPORTANT!*

These improved Bulletin 700 Type B and Type BX relays are establishing new standards for relay life and reliability. New design increases mechanical life by *at least 5 times* . . . a new contact motion insures *at least 10 times* greater electrical reliability. Double break, silver contacts never need maintenance, and the new molded coil is impervious to the most severe atmospheric conditions.

These new A-B relays—with their *extra millions of trouble free operations at no increase in price*—are a bargain in the relay field. Write for complete details, today.

NEW ENCLOSURES

for the Bulletin 700 relays are styled by Brooks Stevens—internationally famous industrial designer. Note the "family" resemblance of these enclosures.

NEMA 1

NEMA Type 1 for general purpose applications with wrap-around cover for ready accessibility. It has a "quality" appearance.

NEMA 4

NEMA Type 4 enclosure for applications that require a watertight and weatherproof seal.

NEMA 7

NEMA Type 7 enclosure for NEC Class 1, Group D hazardous gas locations.

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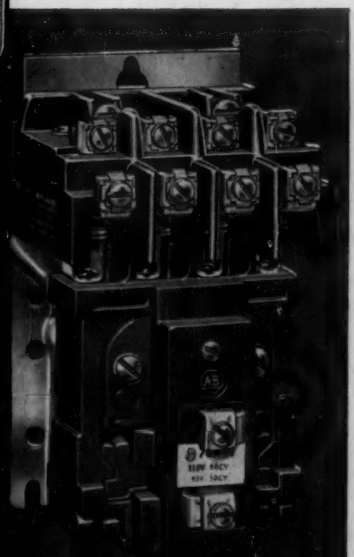
TYPE BR Bulletin 700 convertible contact relay shown with four poles. Made with up to six poles in line.

No other relay offers such simplicity in changing contacts from N.O. to N.C. (or vice versa)—it takes only 60 seconds!

A four pole unit provides any of the contact combinations otherwise available only with five relays of the fixed contact type. You can reduce your relay inventories. In tests, this relay has *proved* it will provide many millions of trouble free operations. Double break, silver contacts never need servicing. Also, each relay can have one or two complete and full rated contacts added to its base—in the field—without increasing space requirements. If you don't know about the Type BR relay, let's get acquainted.



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Planners Map Stepped-Up Attack on Pollution

To lay the groundwork for a vigorous drive against water pollution, Surgeon General Leroy E. Burney of the Public Health Service is calling a national conference on water pollution, to be held in Washington, D. C., December 12-14. The conference stems from President Eisenhower's statement earlier this year in a message to Congress that he wanted "local taxpayers and business concerns to realize the obligations they have to help prevent water pollution."

Aim of the conference will be twofold: (1) to consider the joint interests of government and industry in controlling pollution and (2) to mobilize public opinion behind a national anti-pollution campaign.

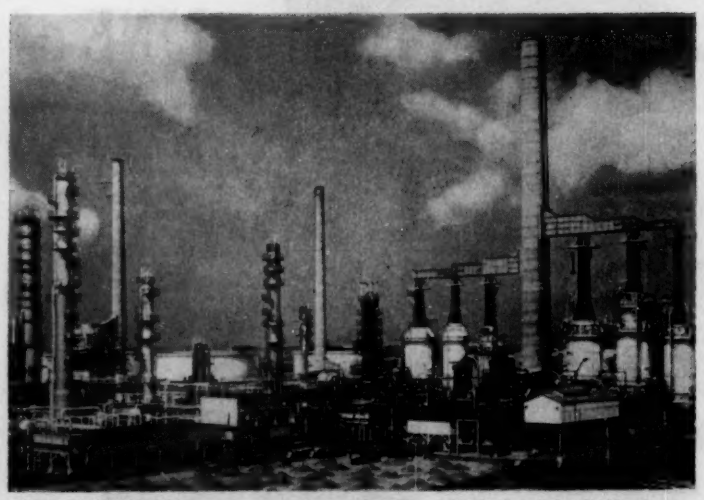
Attending the meeting will be representatives of more than 300 municipal, state and federal agencies; industrial, farm and labor groups; fish, game and boating organizations; engineering, conservation and research associations. The opening session at Washington's Sheraton-Park Hotel will hear an address by the Secretary of Health, Education and Welfare, Arthur S. Flemming.

Soviet Union Boasts Industry-Output Boosts

Soviet Union's Central Statistical Board, reporting to the Communist Party Central Committee last month, claimed major boosts in industrial output in the first half of 1960 as compared with the first half of 1959. Here are some key chemical process industry data.

Synthetic resin and plastic production in first six months of this year is up 11% over same period in 1959. This includes a 66% step-up in polyethylene, and a 23% rise in polystyrene and styrene-butadiene output. Ethylene alcohol output is up 14%; natural gas production, 29%; petroleum production, 15%; electrical power, 11%; chemical equipment manufacture, 54%.

CPI Briefs



NEW REFINERY is now on stream for Esso Nederland in Holland.

Esso Nederland's new refinery at Rotterdam, Holland, is now on stream and operating satisfactorily. Some of the main features of the 100,000-bbl./stream-day plant can be seen in the picture above, including crude distillation equipment on the left and Powerforming (catalytic reforming) facilities on the right. Other units at the new refinery include a naphtha stabilizer, a diesel oil Hydrofiner (desulfurizer) and a copper chloride treater. Total cost of the facility was $50 million; it was built in 24 months by Badger N.V., Dutch affiliate of Badger Mfg. Co., Cambridge, Mass. It will supply Esso's requirements in refined products for the Dutch market, with the rest of its production slated for export. One feature of the new refinery: it is equipped throughout with electronic controls, which permit highly precise plant operation and require significantly less panel board space than conventional controls.

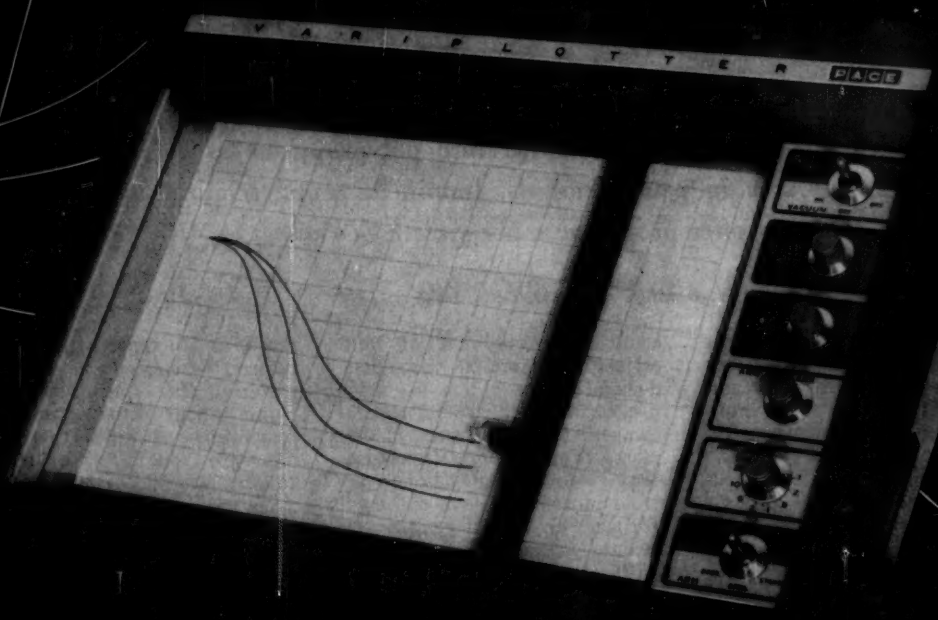
Shell Chemical Co. is expanding styrene production facilities at Torrance, Calif. Scheduled for completion early next year, the move will raise plant capacity to 210 million lb./yr. When Shell acquired its Torrance styrene facilities from the government in 1955, rated capacity was 12 million lb./yr.

Humble Oil & Refining Co. announces plans to increase orthoxylene capacity at its Baytown, Tex., refinery. The jump will be from 44 million to 72 million lb./yr. by the end of 1960, with provision for further expansion to 165 million lb./yr. if demand for the product rises sufficiently. Orthoxylene can be used instead of naphthalene—which is in short supply now—in making phthalic anhydride, and Humble says it will be able to supply orthoxylene at prices that will compete with naphthalene.

Dixie Land & Timber Co., Atlanta, will build a $30-million kraft paper and liner board plant near Phenix City, Ala. Construction, by Stone & Webster Engineering Co., is scheduled to start next Feb-

CPI Briefs
continues on page 170

FOR OUTSTANDING PLOTTING PERFORMANCE...



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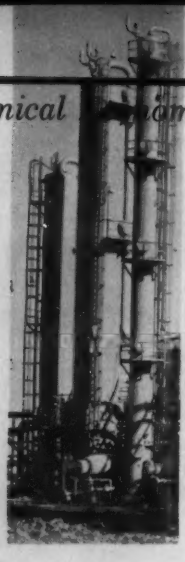

Lineup for the Series

1. Petrochemicals Map Their Mature Years, May 30, p. 54
2. Chemicals From Methane, June 27, p. 74
3. Ethylene Copes With Growing Competition, Aug. 22, p. 66
4. **Propylene Sires Industry's New Hopefuls**
5. Aromatics

Petrochemicals 4

Propylene Sires Industry's New Hopefuls

Available investment capital is going into polypropylene as "the" growth area in petrochemicals. Imminent commercialization of polyisoprene, too, may offer propylene a big growth market.

Richard F. Messing and James W. Bradley, Arthur D. Little, Inc.*

Polypropylene is showing the most dramatic growth of the propylene derivatives and is currently attracting as much interest as any petrochemical—and perhaps more.

Polypropylene in 1959 accounted for only 1% of total estimated chemical propylene demand of 2.1 billion lb., since production facilities of several companies had not yet been completed. Yet prospects are considered so promising that two petroleum refiners have chosen it for their first major venture into resins—Sun Oil (in combination with American Viscose) and Standard Oil of N. J. (Humble Oil & Refining). Polypropylene also will be the first themoplastic material to be produced in this country by a foreign-owned firm. Montecatini, a large diversified Italian company with special know-how in olefin polymerization, has selected polypropylene for its first major U.S. chemical venture.

Estimated Chemical propylene[1] End-Use Breakdown
(Million Pounds)

End Use	1959
Isopropanol	1,100
Short Chain Polymers	570
Propylene Oxide	205
Cumene	80
Synthetic Glycerin	65
Polypropylene	20
OXO chemicals not from propylene polymers (iso octyl alcohol, butyraldehyde, etc.) acrolein, epichlorohydrin (unconverted to glycerin) & misc.	160
Total	2,200

1. Excludes propane for perchloroethylene —carbon tetrachloride synthesis; excludes all non-chemical uses.

High-purity isoprene for use in polyisoprene synthetic natural rubber is another derivative of special interest. However, full-scale commercial production did not take place in 1959. While the first U.S. polyisoprene plant, that of Shell Chemical at Torrence, Calif., reportedly utilized refinery isoamylene as the raw material, the other commercial plants under construction and announced—of which there are five—are thought to be planning to synthesize isoprene monomer from propylene.

Problems of isoprene and isoamylene separation and availability from refineries have focused attention on alternate routes, with propylene appearing as the most likely starting material for new plants. Propylene can be converted to isoprene by dimerization and controlled cracking. An isobutylene-formaldehyde route also has been proposed.

The propylene process now appears to be the preferred route to acrylonitrile. It will be used in plants being built by both Sohio and Du Pont ("Chemicals From Methane," *Chem. Eng.*, June 27, 1960, p. 74).

Propylene oxide, while grow-

* For author's biographies, see Chem. Eng., May 30, 1960, p. 54.

QO® FURFURAL FOR PHENOLICS IMPROVES PRODUCT QUALITY AND MOLDING EFFICIENCY

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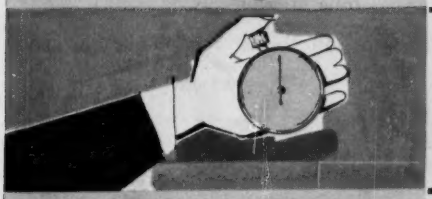

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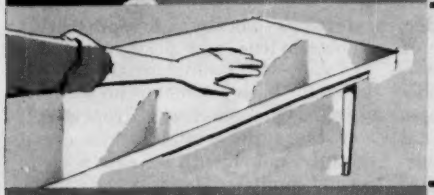

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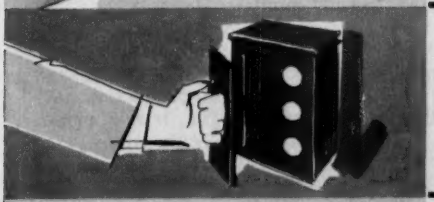

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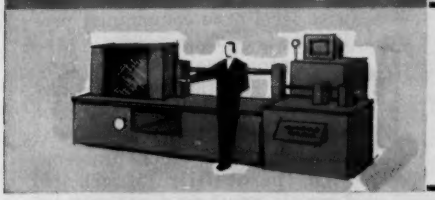

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ing, lacks appeal for new ventures because it is being produced in existing chlorohydrin process ethylene oxide plants.

Exact propylene capacity is unknown, but production is at least 20 billion lb. While the greatest part of this total production represents that from refinery off-gases, 1-2 billion lb. are produced as co-product in plants cracking hydrocarbons to yield ethylene. In addition, at least one butadiene producer is presently recovering and marketing propylene.

Because propylene is a component of refinery streams and a co-product of ethylene production, investment to become a supplier is less than that for ethylene. Smaller refiners are able to participate in propylene where ethylene may not have been feasible, e.g., Ashland Oil's recent announcement.

Polypropylene, unlike many of the older propylene derivatives such as isopropanol and propylene trimer and tetramer, requires 99% plus purity feed and has created a high-purity propylene demand where practically no such noncaptive demand existed previously. As late as mid-1959 there was only one such high-purity merchant propylene supplier—Sinclair Oil at Marcus Hook, Pa. While there has been no uncertainty about adequate propylene supplies per se, facilities for high-purity propylene have had to be constructed. In addition to Sinclair, other companies, including Sun Oil, Phillips Chemical, Petroleum Chemicals, Mobil Oil, and Standard Oil of N. J., have high-purity propylene capacity in place, under construction, or in advanced planning stages.

Petrochemicals 4
Polypropylene and Isoprene Boil Propylene Pot

That real market risks are present in spite of the glowing predictions that have been made for polypropylene is evidenced by examining producers and capacities. Many of the largest established polyethylene resin producers, such as Monsanto, Union Carbide, Du Pont, National Distillers, and Spencer, have yet to announce plants for polypropylene. Of the three commercial-scale plants operating currently — Hercules Powder, AviSun, and Standard Oil of N. J.—the last two are newcomers to large-volume thermoplastic resins. This illustrates that companies with capital available for investment are seizing upon polypropylene as "the" growth area in petrochemicals. Total 1959 production of polypropylene is estimated at 20 million lb.

The competitive situation that develops between low-pressure polyethylene and polypropylene, in view of the substantial capacities for both products, can be expected to be severe. Properties of these two resins, while certainly not identical, are somewhat similar. Many of the Ziegler process polyethylene plants can also be adapted to making polypropylene. Polypropylene, with commercial production having hardly begun, is now priced only about 4-7¢/lb. above low-pressure polyethylene but can be expected to approach the same price level once commercial production is well underway.

Polypropylene's higher temperature resistance and greater rigidity make it a prospective commercial textile fiber in spite of dyeing and other problems. Film, particularly in oriented form, is another significant potential outlet, especially if equipment development permits rapid processing in packaging applications competitively with cellophane. Potential textile markets may be one factor behind American Viscose's affiliation with Sun Oil in a polypropylene venture and part of the rationale behind Hercules Powder's holding discussions with Beaunit Mills concerning possible merger; this merger, however, did not take place.

As for propylene's other fast-burgeoning hopeful, polyisoprene will probably not compete with

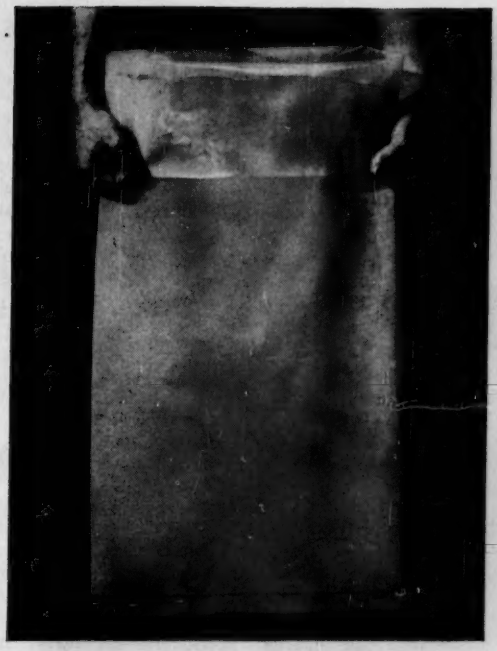
Estimated Polyisoprene and Cis-Polybutadiene Capacity
(Thousand Long Tons)

Producer & Location	Capacity[4]
Shell Chemical	
Torrance, Calif.	20 (inc. u.c.)[1]
Wood River, Ill.	40 (pl.)[1]
Firestone Tire & Rubber	
Orange, Tex.	30 (u.c.)[2]
Goodrich-Gulf	
Orange, Texas or Institute, W. Va.	25 (pl.)[2]
Goodyear Tire & Rubber	
Beaumont, Tex.	25 (u.c.)[2]
Phillips Chemical	
Borger, Tex.	25[2]
American Rubber & Chemical (Stauffer Chem. & American Syn. Rubber)	
Louisville, Ky.	30 (pl.)[2]
	195 (inc. u.c. and pl.)

Estimated Polypropylene Capacity
(Million Pounds)

Producer & Location	Capacity[4]
Dow Chemical	
Bay City, Mich.	10 (u.c.)
Torrance, Calif.	30 (u.c.)
Texas Eastman	
Longview, Tex.	20 (u.c.)
Avisun	
Port Reading, N.J.	20
New Castle, Del.	120 (u.c.)
Hercules Powder	
Parlin, N.J.	40
Lake Charles, La.	50 (u.c.)
Standard Oil of N.J.	
Baytown, Tex.	40
Montecatini (Novamont)	
Neal, W. Va.	25 (u.c.)
Firestone Tire & Rubber	
Hopewell, Va.	10 (u.c. or pl.)
Total	365 (inc. u.c. and pl.)

1. polyisoprene only. 2. polybutadiene only. 3. polybutadiene and polyisoprene. 4. u.c. = under construction; pl. = planned.



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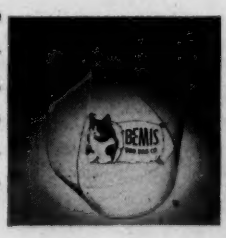

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lower-priced conventional synthetic (S-type) rubber in the near future but will compete with natural rubber, whose molecular structure is identical. About 64% of natural rubber consumption is in tires and tire products, with the remainder in other areas where natural rubber's special properties give it an advantage.

The rubber situation is also complicated by two other synthetic rubbers which have or will have part of their market in tires — cis-polybutadiene and butyl rubber. These two products are discussed later in this article in a section which is devoted to butylene chemicals.

In spite of extensive work with S-type and other synthetics, about 35% of U.S. rubber consumption is accounted for by natural rubber. Polyisoprene will in all probability add a measure of price stability to natural rubber and eliminate the very erratic price situation that has existed in the past.

Petrochemicals 4
Isopropanol Keeps Top-Consumer Spot

Isopropyl alcohol remains the largest single chemical propylene consumer. Total 1959 production is estimated at 1.165 billion lb. Production is concentrated in the hands of three producers—Standard Oil of N. J., Shell Chemical, and Union Carbide. Total capacity is in the order of 1.300 billion lb.

Major use continues to be in acetone manufacture; acetone itself is a solvent and a raw material for methyl methacrylate resin. Acetone is also used to produce other solvents, particularly methyl isobutyl ketone (MIBK) and methyl isobutyl carbinol (MIBC).

Acetone is also produced by two processes not involving isopropanol—the Celanese direct-oxidation process and as a co-product of the cumene-phenol process. In the cumene-phenol process, benzene is alkylated with propylene to cumene (monoisopropyl benzene), which is then converted to phenol. Acetone is a co-product with about 0.6 lb. of acetone produced per pound of phenol. (Phenol will be discussed in the last article on aromatics.) Both acetone and phenol go into bisphenol A; the latter is used for epoxy and polycarbonate resin manufacture.

Isopropanol itself has important solvent and drug use where it comes into competition with more expensive ethyl alcohol. The one interesting new use for isopropanol is the process developed by Shell Chemical which yields hydrogen peroxide as a co-product—oxidation of isopropyl alcohol to acetone and hydrogen peroxide. Shell Chemical's long heralded but only recently completed plant at Norco, La., has an estimated capacity of about 30 million lb. of hydrogen peroxide. Other U.S. hydrogen peroxide plants produce the material by an auto-oxidation process not involving propylene except for Food Machinery & Chemical and Pennsalt, which utilize the electrolytic route.

Estimated Isopropyl Alcohol End-Use Breakdown
(Million Pounds)

End Use	1959
Acetone Manufacture	720
Solvent	190
Misc.	255
	1,165

Petrochemicals 4
Most Perchloroethylene Goes for Dry Cleaning

Estimated Perchloroethylene Capacity
(Million Pounds)

Producer & Location	Capacity	Route
Dow Chemical		
Freeport, Tex.	60	LPG
Pittsburg, Calif.	30	LPG
Du Pont		
Niagara Falls, N.Y.	50	trichloroethylene
Diamond Alkali		
Deer Park, Tex.	45	trichloroethylene
Columbia-Southern Chemical		
Barberton, Ohio	30	LPG
Stauffer Chemical		
Louisville, Ky.	20	LPG
Detrex Chemical Industries		
Ashtabula, Ohio	20	trichloroethylene
Frontier Chemical		
Wichita, Kan.	15	LPG
Total	270	

Estimated Perchloroethylene End-Use Breakdown
(Million Pounds)

End Use	1959
Dry Cleaning	165
Metal Degreasing & Drying	30
Other	5
	200

Production of perchloroethylene in 1959 was 200 million lb. The largest end use, accounting for 82% of total perchloroethylene consumption, was its application as a dry-cleaning solvent. Other uses, such as metal degreasing, are small.

Perchloroethylene is predominantly made by the chlorination of propane (LPG). In this process, carbon tetrachloride is yielded as a co-product. Recycling of carbon tetrachloride can increase effective perchloroethylene capacity. Some plants synthesize perchloroethylene from trichloroethylene; the latter is

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made from acetylene. Reference should be made to the second article in this series (Chemicals from Methane, *Chem. Eng.*, June 27, 1960, p. 74), which discusses both carbon tetrachloride and trichloroethylene manufacture. As noted, of the seven perchloroethylene producers, Du Pont, Diamond Alkali and Detrex Chemical do not use the propane (LPG) chlorination route.

Petrochemicals 4
Propylene Oxide Markets Are Growing Briskly

Estimated Propylene Oxide Capacity[1]
(Million Pounds)

Producer & Location	Capacity
Olin Mathieson	
Brandenburg, Ky.	45
Wyandotte Chemicals	
Wyandotte, Mich.	20
Union Carbide	
S. Charleston, W. Va. / Institute, W. Va.	90
Dow Chemical	
Midland, Mich. / Freeport, Tex. / Plaquemine, La.	140
Jefferson Chemical	
Port Neches, Tex.	40
	335

1. In addition Celanese produces minor quantities of propylene oxide glycol as part of its hydrocarbon oxidation process, but is believed not separated and sold as such.

Estimated Propylene Oxide End-Use Breakdown
(Million Pounds)

End Use	1959
Propylene glycol (for polyesters, hydraulic fluids, etc.)	150
Polyethers (for urethanes & detergents)	52
Polypropylene glycols & misc.	23
	225

No propylene oxide process has yet evolved which is comparable to the direct oxidation process for ethylene oxide. However, propylene oxide can be and is being produced in chlorohydrin-process ethylene oxide units. The economics are such that except under very special conditions of chlorine availability, new plant construction for ethylene oxide is economic only with a direct oxidation process. So propylene oxide demand, at least at present levels, can easily be filled by the conversion of the generally less economic (for ethylene oxide) chlorohydrin units.

Propylene oxide markets are growing for propylene glycol and for polyethers, particularly in polyurethane foam. About 35 million lb. of oxide are consumed in the production of polyethers for urethane foam alone. Toxic characteristics of ethylene glycol have created markets for propylene glycol in the cellophane, food, and drug industries.

Petrochemicals 4
OXO Alcohols Find Most Use in Plasticizers

Estimated OXO Alcohol Capacity[1]
(Million Pounds)

Producer & Location	Capacity[2]
Amoco Chemicals	
Wood River, Ill.	15
Standard Oil of N.J.	
Baton Rouge, La.	120 (inc. 60 u.c.)
Gulf Oil	
Port Arthur, Tex.	12
Philadelphia, Pa.	30 (u.c.)
Texas Eastman	
Longview, Tex.	125
Union Carbide	
Texas City, Tex.	120 (inc. 60 u.c.)
	422

1. Total capacity, including that based on non-propylene or propylene polymer feed. 2. u.c. = under construction.

Production of OXO alcohols is relatively straightforward, uses refinery raw materials. Sales are mostly to a few large users, and investment requirements are moderate. Therefore, it was one of the early areas of upgraded petrochemicals to be entered by the oil industry.

The major OXO alcohol, isooctyl alcohol from heptene, competes with octyl alcohol made by the aldol process. Tennessee Eastman is believed to use propylene directly in an OXO unit to produce butyraldehyde and isobutyraldehyde and derivatives. Part of the butyraldehyde produced then undergoes an aldol condensation to yield 2-ethyl hexanol. (Butyraldehyde is also produced from acetaldehyde via an aldol condensation.) Union Carbide may also be using propylene directly for some OXO alcohol production.

In addition to propylene and its polymers, other olefins, principally heptene and butylene, are raw materials. Some plants may feed an olefin-containing stream and effect production of various products by separation after the OXO reaction takes place. Competition to the OXO route may come from new Continental Oil's process based on ethylene, which will be capable of producing a series of alcohols similar to those made by the OXO process. The major market for OXO alcohols is in vinyl plasticizers.

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Petrochemicals 4
Short-Chain-Polymer Use Depends on Detergents

Second as consumers of chemical-grade propylene are the short-chain propylene polymers —principally propylene trimer (nonene) and propylene tetramer (dodecene). Production of these propylene polymers is wholly accounted for by the petroleum industry.

The major market for tetramer is in the production of dodecyl benzene-based detergents. Propylene trimer shares in the detergent market for nonyl phenol type surfactants and has a market as a raw material in the production of C_{10} (decyl) OXO alcohols. Some tetramer is converted to C_{13} (tridecyl) OXO alcohols. Of current interest is propylene pentamer for detergent use. Standard Oil of Calif. and Standard Oil of N. J. are two known commercial producers of the pentamer, which will have its primary use in detergents.

Petrochemicals 4
Synthetic Glycerine Sources Rise to Three

The number of U. S. synthetic glycerin producers, including those with plants under construction, has grown to three, and a second process has come on stream. In addition to Shell Chemical, which pioneered synthetic glycerin production at Houston, Dow Chemical at Freeport, Texas, has become a producer, and Olin Mathieson currently has a plant under construction at Brandenburg, Kentucky. These three plants are using or will use what has evolved as the conventional synthetic glycerin process—the addition of chlorine to propylene through allyl chloride and epichlorohydrin; finally, the epichlorohydrin intermediate formed is converted to glycerin. Epichlorohydrin also is a major raw material for epoxy resins.

Shell Chemical has brought on stream a second synthetic glycerin plant at Norco, La., utilizing a different process to produce glycerin, although it too is based on propylene. The latter route does not require chlorine. Here propylene is converted to acrolein by an oxidation step. The latter is oxidized to glyceraldehyde with hydrogen peroxide (also from propylene) and then converted to glycerin. 1959 synthetic glycerin production is estimated at about 110 million lb.

Petrochemicals 4
Butylene Derivatives Promise Healthy Growth

Cis-polybutadiene is the major new commercially important C_4 derivative which has evolved in recent years. Butylene-maleic anhydride process, developed by Petro-Tex, and the Buton-type resins made by Standard Oil of New Jersey and Texas Butadiene Chemical may become significant. Other derivatives, are still exhibiting good growth prospects.

► **Butadiene**—Butadiene is the largest volume C_4 petrochemical, and of all petrochemicals is second in volume only to ammonia. The 1959 production totaled 916,000 tons compared to an industry capacity in place of 1.240 million tons. While butadiene continues to be made by the dehydrogenation of normal butylenes, the one-step process employing butane as the feed (Houdry Process) is used by the more modern plants.

Butadiene consumption remains tied to the production of low-cost versatile S-type rubber. In 1959, domestic uses outside of S-type rubber accounted for only about 76,000 tons. As a starting material for adiponitrile, one of the raw materials for nylon 66, butadiene competes with both cyclohexane and furfural. High impact styrene polymers represent a growing but still very small demand. Standard Oil of New Jersey's Buton resins, derived from butadiene, have interesting prospects, particularly in the coatings market. Texas Butadiene & Chemical is also becoming active in this area. Exports during 1959 reflected operation of European S-type rubber plants before adjacent butadiene units came on stream.

► **Polybutadiene**—The one potentially commercially significant new butadiene derivative is cis-polybutadiene. This material, while not a complete replacement for natural rubber, can be used with natural rubber up to 50% or more without major changes in physical properties of the resulting mixture when compared to 100% natural rubber. Polybutadiene markets, therefore, will be in the same market areas as polyisoprene and natural rubber. Up to the present, only Phillips Chemical and Shell Chemical have indicated they have definitely decided on only one of the two "natural type" synthetic rubbers — polybutadiene and isoprene, respectively. The remainder claim both types will be produced with indications that polyisoprene will follow

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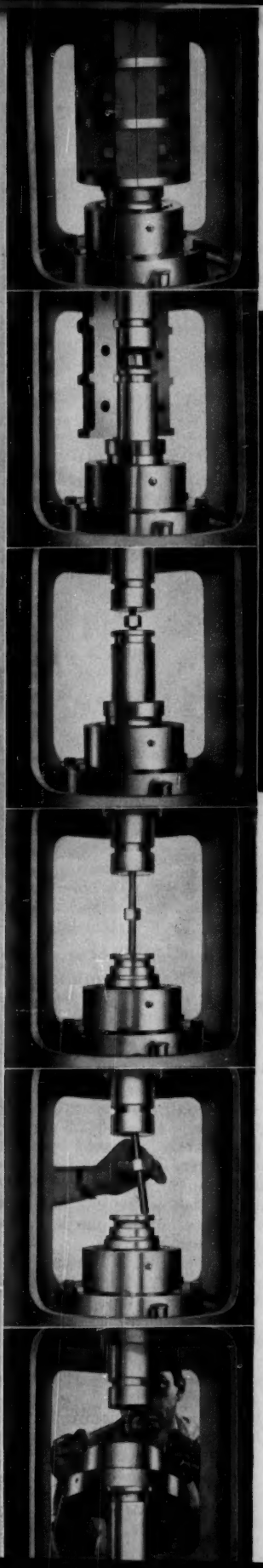

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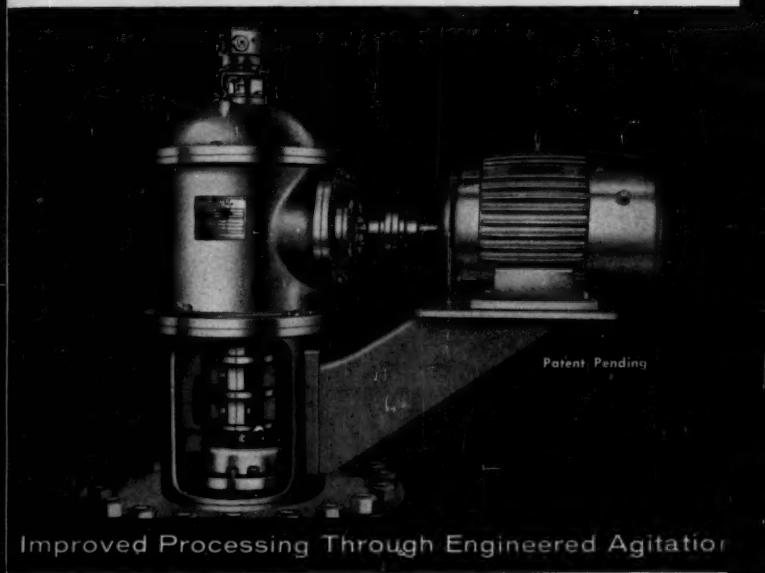

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Estimated Butadiene Capacity[1]

(Thousand Short Tons)

Producer & Location	Capacity[2]
Copolymer Rubber & Chemical, Baton Rouge, La.	40
Dow Chemical, Midland, Mich. / Freeport, Tex.	32
Esso, Baton Rouge, La.	55
Firestone Tire & Rubber, Orange, Tex.	60
Goodrich-Gulf and Texas-U.S., Port Neches, Tex.	295
Humble Oil & Refining, Baytown, Tex.	65
Odessa Butadiene, Odessa, Tex.	50
Petroleum Chemicals, Inc. (Cities Service & Continental Oil), Lake Charles, La.	80
Petro-Tex Chemical (FMC & Tenn. Gas), Houston, Tex.	200
Phillips Chemical, Borger, Tex.	112
Socony Mobil Oil, Beaumont, Tex.	10 (u.c.)
Shell Chemical and Std. Oil of Calif., Los Angeles, Calif.	86
Texas Butadiene & Chemical, Houston, Tex.	120
Union Carbide, Texas City, Tex. / S. Charleston, W. Va.	45
	1,250

1. Source: Fourth Report of the Attorney General on Competition in the Synthetic Rubber Industry and A. D. Little, Inc. 2. u.c. = under construction.

Estimated Butadiene End-Use Breakdown

(Thousand Short Tons)

End Use	1959
S-type Rubber	830
Nylon	25
Nitrile Rubber	25
Hi-Impact Styrene & Misc.	21
Export	15
Total	916

after polybutadiene production has begun.

▶ **N-Butylenes** — Normal butylenes are used to produce secondary butyl alcohol and to a lesser extent in the OXO process to manufacture amyl alcohol. The bulk of secondary butanol production is consumed in methyl ethyl ketone (MEK) production. Secondary butanol producers are Shell Chemical, Standard Oil of N. J., Union Carbide, and Standard Oil of Calif. Amyl alcohols can also be produced from pentanes and are produced as a by-product in the ethyl alcohol fermentation process.

▶ **Isobutylene**—Butyl rubber is about 98% isobutylene and is the largest chemical consumer of this olefin. Standard Oil of N. J. at Baton Rouge, La., and at Baytown, Tex., is the only U. S. producer. Butyl rubber production in 1959 amounted to about 81,000 long tons, up more than 28,000 tons, over the previous year. Reported domestic butyl rubber consumption in 1959 was 65,500 long tons, of which about 51,500 tons or 79% was for tires, tubes, and bags. During 1959, butyl exports grew in importance and amounted to about 22,000 long tons. While Standard Oil of N. J. is now marketing all butyl rubber Bucron tires as a premium product, these have not materially cut into S-type rubber markets for tire. However, the soft-riding qualities of butyl tires did force the tire industry to produce an S-type passenger car tire with comparable riding properties. Butyl rubber also has other applications where its ozone resistance and low gas transmission characteristics are factors.

Isobutylene's second major use is for polyisobutylene which has its market primarily in lube-oil additives, sealing compounds and as a rubber sealant, plasticizer, and extender. Current producers of polyisbutylene include Standard Oil of N. J., Standard Oil of Ind., and Standard Oil of Calif.

Tertiary butanol is produced from isobutylene; the only reported producer is Shell Chemical Corp. Tertiary butanol is consumed mainly as a component of industrial cleaning compounds.

Di-isobutylene is used in the production of octyl phenol and in the manufacture of nonyl alcohol by the OXO process.

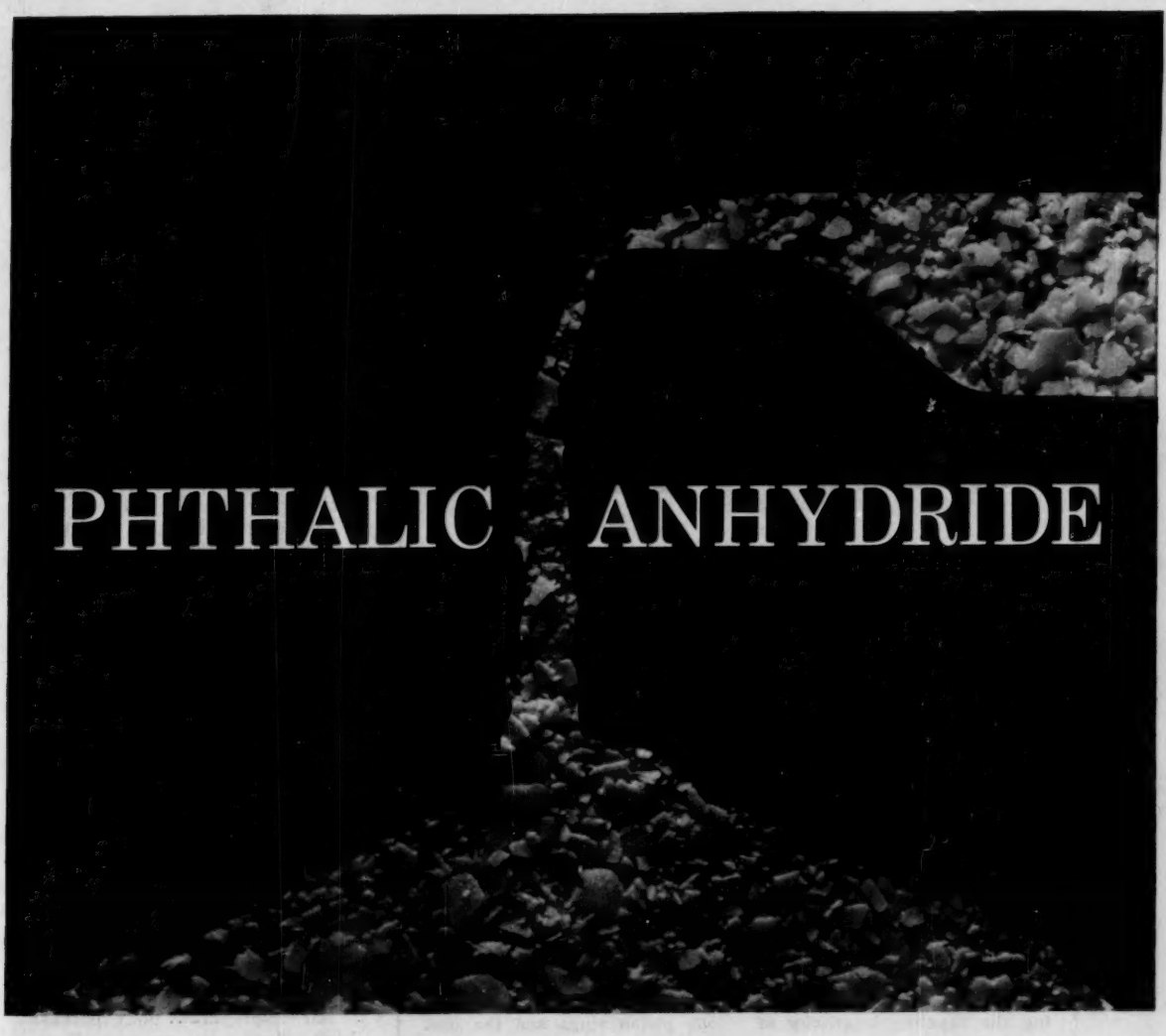
A possible use for isobutylene exists in the production of methyl methacrylate resin. A process has been developed by Escambia Chemical which while yet uncommercialized could add to chemical demand. Isobutylene would be oxidized under controlled conditions to methacrylic acid. Petro-Tex has announced plans to make maleic anhydride by a process it developed using butylenes as raw material instead of benzene, the conventional starting material. Details on this process have not been revealed but company has announced plans for a 30 million lb./yr. plant.

Isooctyl alcohol is a mixture of C_8 alcohols produced by the OXO process from heptenes. Heptenes are produced in polymer gasoline plants from butylenes and propylene; butylene is not isolated but is a part of the polymer gasoline cut fed to the OXO unit. Butylenes are produced as a part of refinery operations and are rarely shipped or sold as such but are normally used for alkylate or polymer gasoline. These non-chemical uses of butylenes (and butanes) like those of propylene (and propane) have been excluded from this discussion. Butylenes are also produced from the dehydrogenation of butane and also as a co-product of ethylene plants when C_4 or higher hydrocarbons are used as raw materials.

Germans Import, Export More Plastics

During the first five months of 1960, exports of the West German plastics industry showed a 27% increase over the corresponding figure of 1959, climbing to $62.3 million. Imports increased by almost 33% to $20.7 million, of which 37.5% came from the U. S. During 1959, Germany's per capita consumption of plastics reached 27 lb., exceeding this country's 25 lb.

German plastics production during the first five months of 1960 amounted to 402,000 tons, 37% more than during the corresponding period of last year. Projecting production figures for the first five months to the full year, production in 1960 will amount to 1 million tons compared to 795,000 last year.



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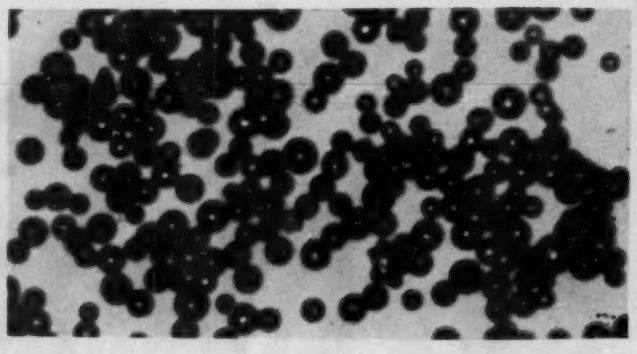


Spherical Metallic Beads Serve as Fuel Additive

A recently developed process allows metals and alloys to be powdered into small spherical beads that range in size from 20 to 150 microns with a uniformity rate of 98%; the photograph shows a 10-20-micron-size nickel powder at 100 magnification. Copper, aluminum, tungsten, nichrome and 316 SS are other powders now available in limited quantities.

Free of voids, cavities and inclusions, these tiny particles increase the thrust of solid-fuel rocket propellants by improving the burning stability and reducing the handling sensitivity of the fuel. Aluminum powder, in particular, is currently receiving a good deal of attention.

Highly reactive powders may be handled with less hazard when they are converted into spherical beads that afford the minimum surface-to-volume ratio. Making use of standard procedures under inert atmospheres for processing, handling and shipment, Zircaloy II wire has been converted into powder, and the process is suitable for other reactive materials.

Spherical powders improve the flow of angular powder particles into molds and better the quality of sintered bodies that require controlled porosity. This suggests uses in filters, burner plates, sweat-cooled nozzles, porous piston rings and the like. And they can be separated into various size ranges and used to calibrate size-analyzing equipment.—Linde Co., Div. of Union Carbide Corp., New York. 72A

Modified Cellulose

Resin brightens future of electroluminescent lighting and microminiature parts.

Cyanocel, a white, fibrous solid made by cyanoethylation of highly refined cellulose, has the highest dielectric constant (12.5) of all known organic film-forming materials. It exhibits such a low dissipation factor that its capacitance per unit volume can be two to six times greater than that of other comparable products.

This material can be molded at high temperature and pressure, and extruded into clear, transparent films (0.1-5 mils thick) in organic solvents. Its first commercial use will be in an electroluminescent lamp made by General Electric. And capacitor manufacturers have long been looking for a material with as high a dielectric constant.

In the new lamp, which does away with bulbs, tubes and hanging fixtures, Cyanocel is sandwiched between two conducting plates and acts as a carrier for glowing phosphors excited by electrical energy.

In addition to their good electrical properties, Cyanocel films show flexibility and physical strength—at 23 C. and 50% humidity, 2-mil films have a tensile strength of 5,380 psi. and a Young's modulus of 3.4×10^5 psi. Plasticizers, when properly chosen, can change the mechanical properties of the films without altering the electrical properties.

Cyanocel is available in either a dry form ($27/lb.) or as a 10% solution.—**American Cyanamid Co., New York. 72B**

Lubricants

Family of synthetic fluids offers wide range of service.

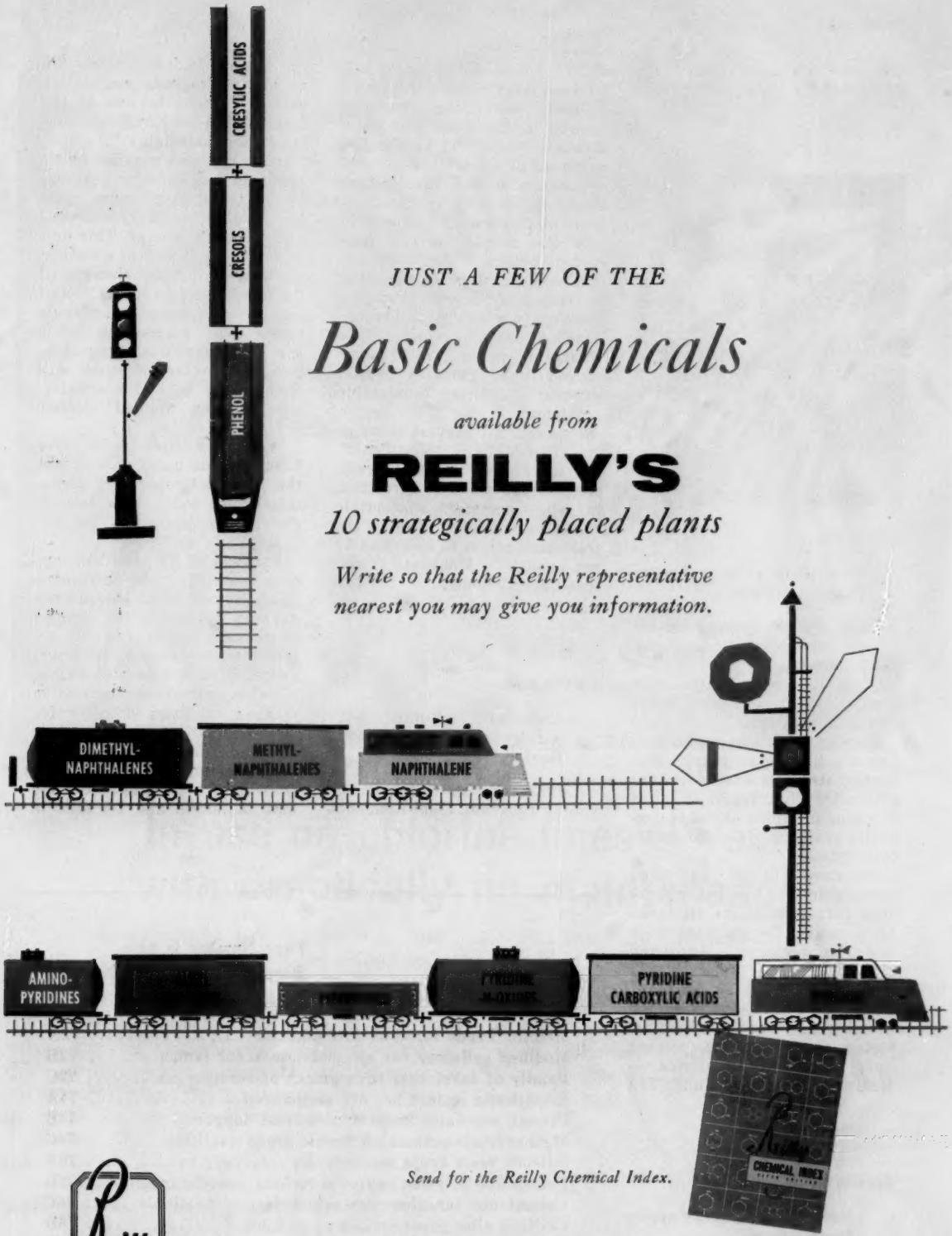
Prepared by polymerization of propylene oxide—or propylene oxide and ethylene oxide—with a new type initiator, Ambiflo lubricants comprise 21 different viscous liquids that are either water soluble or insoluble.

All display low pour points, high flash points, excellent viscosity-temperature relationships, good organic solubility and compatibility with a wide variety of inhibitors.

As brake fluid components, the new products create negligible swelling on most rubbers and are noncorrosive. And because of high-temperature stability and cold-water solubility, some Ambiflo members are reported highly suitable as textile lubricants and their use has resulted in excellent antistatic qualities.

In tire manufacturing, Ambiflo lubricants eliminate sticking when tires are removed from bladders and air bags.

Increased production rate, longer tool life and cooler work pieces with resultant low distortion are other advantages offered by these lubricants in metalworking formulations. —



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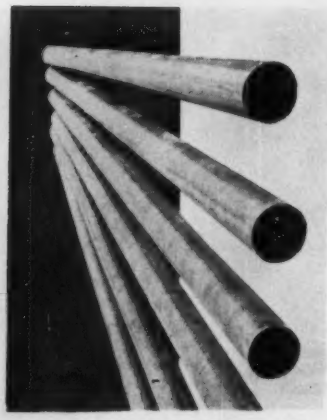
The Dow Chemical Co., Midland, Mich. 72C



Plastics

New resin extends plastic pipe usefulness.

Pipes made from Dion-Iso DR-661, a new isophthalic resin, are designed to operate in continuous duty up to 350 F., and easily handle solvents, acids and alkalis.

Increased fatigue resistance, longer life expectancy and higher strength are additional attributes that claim to push this kind of piping ahead of currently available glass-fiber polyester pipes.

Standard Oil Co. has used formulations of the resin to prevent corrosion of its oil tanks by spraying the surfaces with resin-impregnated, chopped glass-fiber.

Pipes are available in 4-, 6-, 8-, 10-, and 12-in.-dia. sizes and are recommended for municipal water supplies, food, mining and petroleum industries. — **Reflin Co., San Diego, Calif. 74A**

Growth Regulator

New chemical keeps apples fresh longer.

Formation of brown spots that give a familiar bitter taste to apples can be effectively prevented by "Stop Scald." Chemically 1,2-dihydro-6-ethoxy-2,2,4-trimethylquinoline, this antioxidant has been recently cleared by the Food and Drug Administration and by the Department of Agriculture.

Common scald — manifesting itself in brownish discolorations and softening of the pulp —is the single most serious storage hazard to the 70-80 million bushels of apples marketed as fresh produce each year, and accounts for an $8-million annual loss to apple growers. Previously wrapping in oiled paper proved to be the only partial solution to this unpalatable problem.

Now one postharvest spray or dip (two pints of "Stop Scald" per 100 gal. of water) is sufficient to prevent spot formation in all commonly susceptible varieties of apples. Cost of the treatment comes to less than 5¢ per bushel. — **Monsanto Chemical Co., St. Louis. 74B**

Crystals

Doped and high-purity metals enter the electronic field.

Culminating a two-year research program, Semi-Elements Inc. has succeeded in producing an electronic-grade magnesium oxide that will be one of the future high-temperature semiconductor materials.

Other research programs have begun to look into the feasibility of using magnesium oxide to develop a double-crystal maser-interferometer. This proposed device is part of a method of determining the changes of the band levels as a function of impurity concentrations. Single crystals of magnesium oxide are being grown at present to find a combination that will change the optical characteristics of an applied electric field.

With a melting point over 5,500 F., this material combines the highest temperature dielectric known today with ease of cleaving, machining and fabrication.

Because of its high-temperature stability, the ultrapure grade can be used in semiconductor devices. The doped magnesium oxide can be obtained with a grown injunction and utilized as a barrier device. Another important application is as a radiation detector for measuring the fields of nuclear irradiation at high fluxes.

Magnesium oxide is available in whiskers ranging from 3-4 mm. in length and 1-5 mils in

Newsworthy Chemicals

Page Number is also Reader Service Code Number

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Modified cellulose for electroluminescent lamps..... 72B
Family of lubricants runs gamut of services..... 72C
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CF_2Cl creates temperatures below −100 F..... 76F

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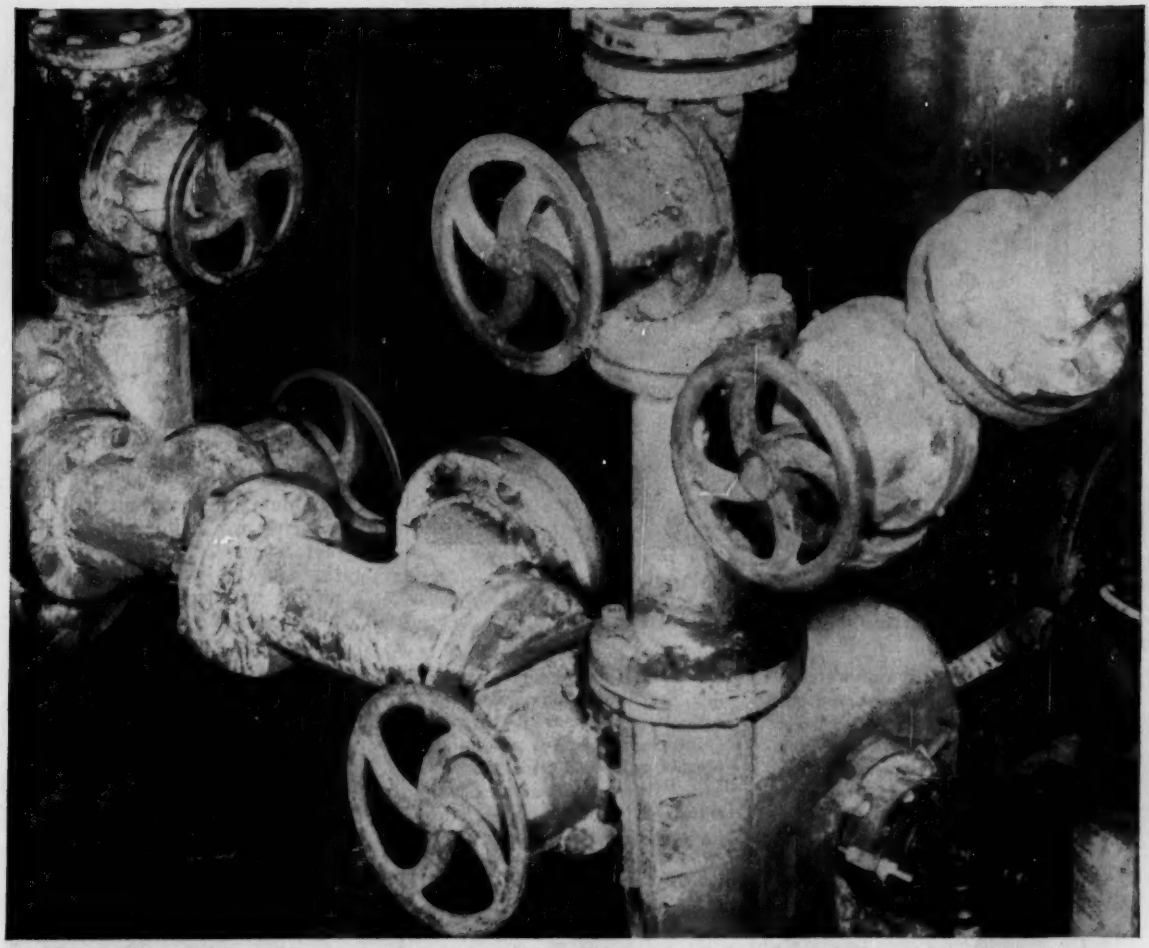


Cluster of 5 Grinnell-Saunders Valves in electrolytic plant of the S. D. Warren Company, Cumberland Mills, Maine, where chlorine solution is made. The 5" rubber-lined Grinnell valves with rubber diaphragms are on lines going from storage tanks to hardwood bleach. Valves here have been in use 9 years with very little service required.

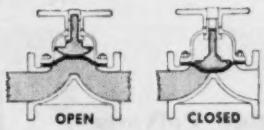
In use on chlorine lines 9 years with practically no maintenance!

It's the design of the Grinnell-Saunders Diaphragm Valve, plus selection of the correct body and diaphragm materials, which make it long-lasting.

The product in process is isolated from the valve's working mechanism at all times, so there can't possibly be any corrosion from that source. No product contamination can occur through contact with the operating mechanism, because the diaphragm effectively "seals off" the fluid in the line. The only part of the valve normally subject to wear is the diaphragm — which can easily be replaced without removing the valve from the line.

You can have Grinnell-Saunders Diaphragm Valves in a wide choice of body, lining and diaphragm materials. For further facts about Grinnell-Saunders Diaphragm Valves, see Grinnell's insert in Chemical Engineering Catalog, or Sweet's Plant Engineering File — or write directly to Grinnell Company, Providence 1, Rhode Island.

In the "open" position, the diaphragm lifts high for streamline flow in either direction.



In the "closed" position, the resilient diaphragm seals tightly, even over fibrous particles and grit.

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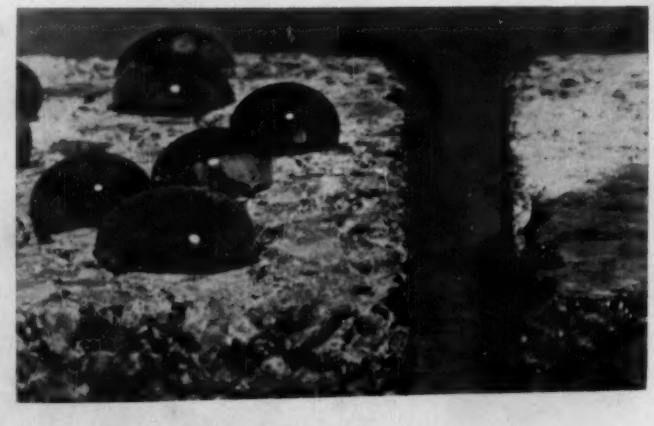

Silicone "Raincoat" Keeps Masonry Dry

Protective action of water repellant formulations based on a new silicone resin, Dri-Film (R) 144, is shown in laboratory demonstration after water splash treatment. Untreated brick (right) absorbed water immediately.

Applied at 5% concentration, this resin reduces water absorption of common brick from 20% to 0.05%, based on the weight of the dry brick, and water absorption of mortar from 8% to an average of 0.62%. In other formulations, it minimizes or eliminates efflorescence, spalling, cracking, staining and discoloration of masonry surfaces.

Interior damage of paint, plaster and wood trim, that results from moisture seepage through the outside walls, can be completely eliminated. Dri-Film (R) 144 contains a minimum of 33% silicone resin solids in hydrocarbon solvents and weighs 7.4 lb./gal. It has a one-year storage stability and can be further thinned with petroleum spirits. — General Electric Co., Waterford, N. Y. 76A

cross section. Full production of semiconductor-grade cadmium telluride, a polycrystalline material used for growing single-crystal cadmium telluride, has also been announced.— **Semi-Elements Inc., Saxonburg, Pa. 74C**

Polysulfide Polymer

Has punch of hydrocarbons for rocket fuels.

High performance of hydrocarbons plus superior processing and broad performance properties of polysulfides characterize the solid propellant rocket binder, C-12.

Hydrocarbon is a prime interest to rocket specialists because it improves specific impulse. And C-12 contains more hydrocarbon than present hydrocarbon formulations because the latter require a high percentage of other ingredients to achieve a cure. The new binder possessing superior low-temperature flexibility and resistance to aging at high temperatures, is now being evaluated to determine optimum viscosity and molecular linkage.— **Thiokol Chemical Corp., Trenton, N. J. 76B**

For More Information about any item in this department, circle its code number on the **Reader Service** postcard (p. 201)

BRIEFS

Columbium and tantalum pentachloride for manufacture of metal-organics, and production of the two high-purity metals and their alloys, are now available in commercial quantities. Both compounds are over 99.5% pure, come in 360- and 150-lb. containers under inert gas. — **Stauffer Chemical Co., New York. 76C**

Cr-Ni-Si alloy, tradenamed Supertherm, provides service up to 2,300 F. Listed among immediate applications are: Heat-treat furnace parts for steel and automotive industries, smelting and calcining furnace parts. — **Electro-Alloys Div., American Brake Shoe Co., Elyria, Ohio. 76D**

Aliphatic cationic chemicals, Armoflo 48, 65 and 66, originally developed to prevent caking of hygroscopic materials, have been found to display excellent dust control in fertilizer manufacturing. One pound of Armoflo sprayed in liquid form provides caking and dust control for one ton of fertilizer.—**Armour Industrial Chemical Co., Chicago. 76E**

A monochlorotrifluoromethane, named Isotron 13, is a refrigerant needed to create temperatures below −100 F. Now under production, Isotron 13 will be useful in low-temperature research of aircraft, missiles and automotive systems. — **Pennsalt Chemicals Corp., Philadelphia, Pa. 76F**

Cleveland Speed Variator is the Best Answer to *Precision Control* of Variable Speed Output

Advanced-designed Cleveland Speed Variators—available in 18 models ranging from fractional to 16 hp at 1750 input RPM—accurately provides dependable, infinitely variable speed control. They give stepless speed over a full 9:1 range—from ⅓ to 3 times input speed. Instant smooth change of output speed can be adjusted by either manual, automatic or remote control. Precise adjustments are always made with accurate adherence to settings.

Thousands of Variators are in daily use on such varied industrial equipment as cigarette-making machines, textile machinery, metalworking machinery, pharmaceutical equipment, transfer tables, conveyors and experimental and testing equipment of many types.

Check these major Variator advantages:

- An extremely compact unit with input and output shafts in line and rotating in the same direction
- Almost any input speed up to 1800 RPM can be used —either clockwise or counterclockwise rotation
- Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant output torque over a 6:1 range
- Speeds infinitely variable over entire range of adjustment
- No slippage—positive torque response mechanism adjusts in direct proportion to the loads encountered
- Long life and minimum maintenance due to absence of belts or complicated linkages
- Ample bearing support for overhung pulleys on both input and output shafts

Write today for free Bulletin K-200 containing detailed description, photographs, sectional drawings, rating tables and specifications.

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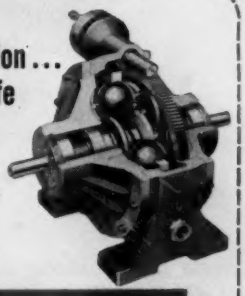
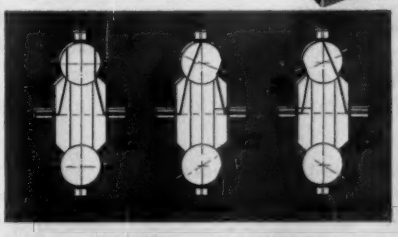
Simple in Operation... Built for Long Life

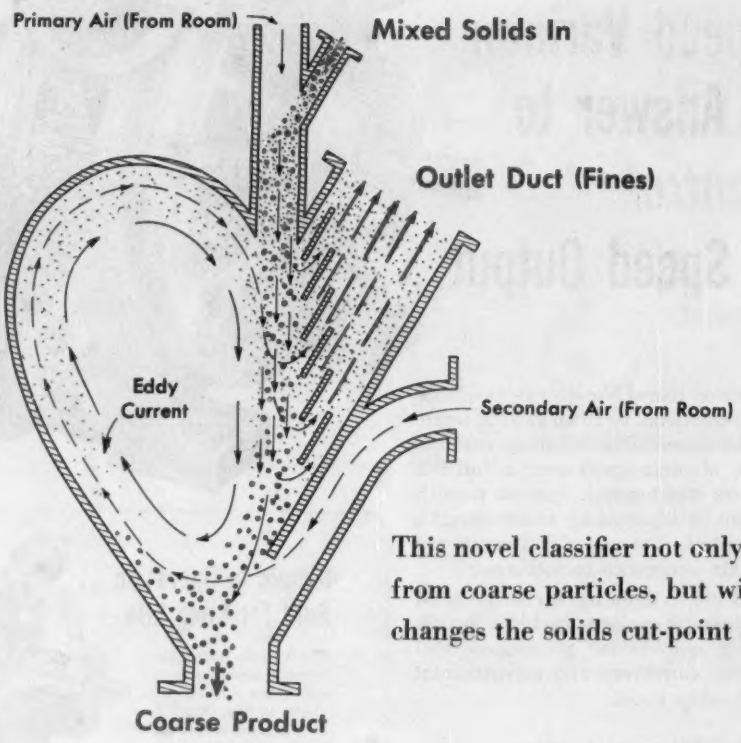


The Variator is an extremely compact unit with input and output shafts in line, rotating in the same direction. It incorporates ample bearing support to carry overhung pulleys.



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with the drive discs. Relative shaft speeds are adjusted by changing position of axles on which the balls rotate.

CLEVELAND SPEED VARIATOR



This novel classifier not only separates fine from coarse particles, but with one adjustment changes the solids cut-point over a wide range.

Solids Separate Sharply in Air Classifier

"Close the secondary air gate, Bill. We're making −200-mesh product today."

This instruction — hypothetical, but possible—emphasizes the versatility of a pneumatic classifier developed by Buell Engineering Co., Inc. Called the Gravitational-Inertial Classifier (GIC), the new commercial unit can have its solids cut-point shifted over a range as large as 65 to 200 mesh simply by adjusting the secondary air gate from fully open to fully closed.

When designed for a specific separation at a single cut-point, the GIC gives efficiencies as high as 95%. After the unit is installed, an operator can adjust the secondary air flow with the gate to assure maximum separation efficiency on a particular stream.

Commercial applications of the unit to date have included dust recovery and classification of phosphate rock, limestone, iron ore, sodium phosphate and soda ash.

▶ **High-Capacity Unit** — A typical installation, in the Pierce, Fla., plant of American Agricultural Chemical Co., handles 8,000 lb./hr. of phosphate rock, cuts it into ±100-mesh portions. The coarse product contains about 5% fines; the fine product contains about 6% coarse material.

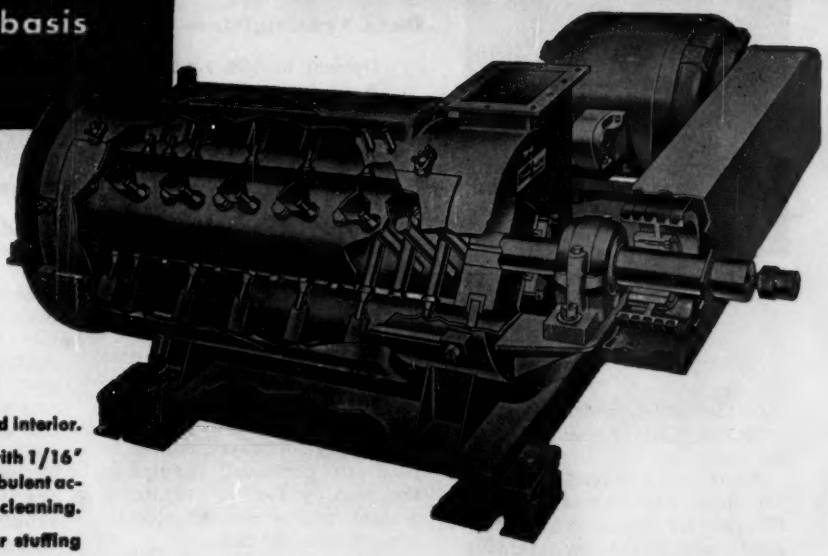
Even at the GIC's relatively high separation efficiency of 95%, respective stray particles are very near the cut-point size. This results from the classifier's design—particles of exactly cut-point size can go either with the fines or the coarse material. Near-size particles may also go either way.

▶ **Uses Inertia**—The GIC separates fine and coarse particles in the same way that most pneumatic separators do. Particles flowing in a stream are forced to change direction. Heavier particles resist the change more than lighter (finer) ones.

As the artist's sketch shows, mixed solids are carried into the classification chamber from above by the primary air. As the stream passes down past vanes mounted in the inclined outlet duct, some of the air and fines, making a sharp 120-deg. turn, are drawn through the vanes

There's one sure way to get intimate mixing of dry and semi-dry material on a continuous basis

Strong Scott TURBULIZER®



EXCLUSIVE TURBULIZER FEATURES

- Heavy steel shell with machined interior.
- Paddles revolve at high speed with 1/16" clearance to shell, creating a turbulent action that makes Turbulizer self-cleaning.
- Choice of lip type, air purge or stuffing box seals. All are of split construction for quick disassembly. (Lip type seal shown.)
- Hinged door is machined as an integral part of the shell giving a perfectly smooth interior surface.
- May be equipped with jacket up to 150 PSI for heat transfer medium.
- Hollow rotor shaft for heat transfer medium gives added temperature control.
- Inlet nozzles available for adding liquids.
- Quick acting heavy lug type catches—no nuts or bolts to remove.
- Tangential inlet and discharge prevent material hang-up.
- Heavy duty outboard bearings.
- Rotating joints for easy connection to heat transfer medium source.

The Turbulizer solves many dispersion problems in the chemical and food industries. Adjustable-pitch paddles, revolving at high speed, result in the combined action of turbulence, shear and impact providing intense dispersion. These actions can be varied to obtain desired results on a specific material.

A completely smooth inner surface with 1/16" clearance paddles, assures thorough mixing, eliminates material hang-up, leaves no dead pockets of unmixed material and provides a self-cleaning operation.

In addition to the numerous features shown here, advantages of the Turbulizer include better product uniformity, increased production, plus lower labor, installation and up-keep costs.

Write for complete details...

Please send information on the Turbulizer

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TITLE_____

COMPANY_____

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The Strong Scott Mfg. Co.

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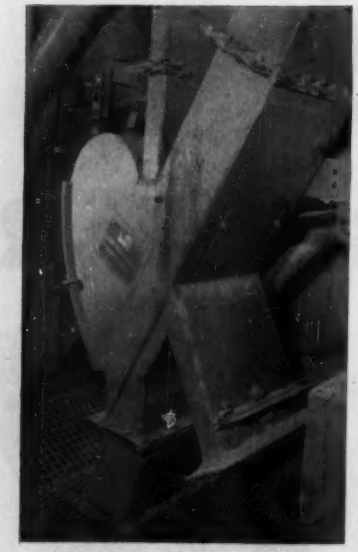
EQUIPMENT DESIGNED FOR BETTER PROCESSING



CLASSIFIER, with secondary air duct and gate in the foreground.

into the outlet, which is maintained at a slight negative pressure.

Fines are removed from the air in a conventional cyclone. Cleaned air passes into an exhaust blower that maintains a vacuum of about 1 in. of water on the outlet duct.

►**Scrubbing Action** — Coarse material, prevented by inertia from making the turn into the vanes, continues downward. The secondary air, drawn in by the vacuum, crosses the coarse material near the bottom outlet, scrubs away any fines adhering to the larger particles.

The secondary airstream, combining with any undiverted primary air, forms a sort of eddy current. Directed by the inside configuration of the classifier chamber, the eddy current travels to the outlet duct and exits.

Particle cut-point is controlled by regulating the secondary air flow. The exhaust blower draws air through the inclined outlet duct at a constant rate. The quantity, and hence velocity, of the primary air, will vary as the secondary air supply varies.

Since velocity of the primary air determines what size particle will or will not make the turn into the inclined outlet duct, larger primary air flow will shift the cut-point toward finer separation, and vice versa. Thus, the gate that regulates how much secondary air is drawn in also regulates the cut-point by a single adjustment.—**Buell Engineering Co., Inc., New York, N. Y.** 78A

Data Transmitter

Optical system reports remote instrument readings.

Gathering information from a number of remote instruments and reporting it at a central location is the function of a new device known as a shaft position digitizer. The self-powered instrument can translate readings of pointer-type instruments into recordable digital form.

The new device comes in two parts—one to read the dial, another to report the result. A mirror is fitted to the dial needle on the gage or instrument to be read. On command, a rotor in the reading device, containing a light source and an electric eye, sweeps 360 deg.

When rotor passes a preset starting point, a contact starts a pulse count at the central logic (report) device. When the rotating light reaches the mirror on the dial, a second contact is made. Central logic counts the pulses between contacts, converts them into a number that is flashed at the control board. Elapsed time: ½ sec.

Estimated cost of installation is about $200 per remote connection; cost of central logic: $400-700. Instrument draws 2-w. power. — **Advanced Instrument Corp., Richmond, Calif.** 80A

For More Information

about any item in this department, circle its code number on the

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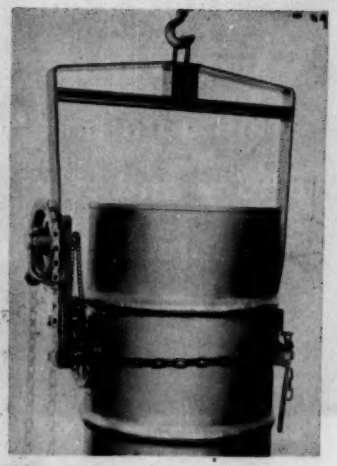


Drum Carrier

Eliminate hand tipping with remote control unit.

Safety and convenience are both served in a new drum carrier that operates by remote control. Dubbed Kontrol-Karrier, it allows operator to lift and pour drums without physical exertion.

The unit has a horseshoe-shaped steel frame, linked at the tips to a saddle. When the saddle (half steel band, half chain) is snapped around a drum with the frame hooked to an overhead hoist, the drum is ready for lifting.

To pour drum's contents, operator pulls a chain that turns a wheel. A series of pulleys and gears rotate the saddle (and tip the drum). Pulling chain in opposite direction tips drum back to upright position.

Kontrol-Karrier can handle 800-lb. liquid and 500-lb. dry loads. — **Morse Mfg. Co., E. Syracuse, N. Y.** 80B

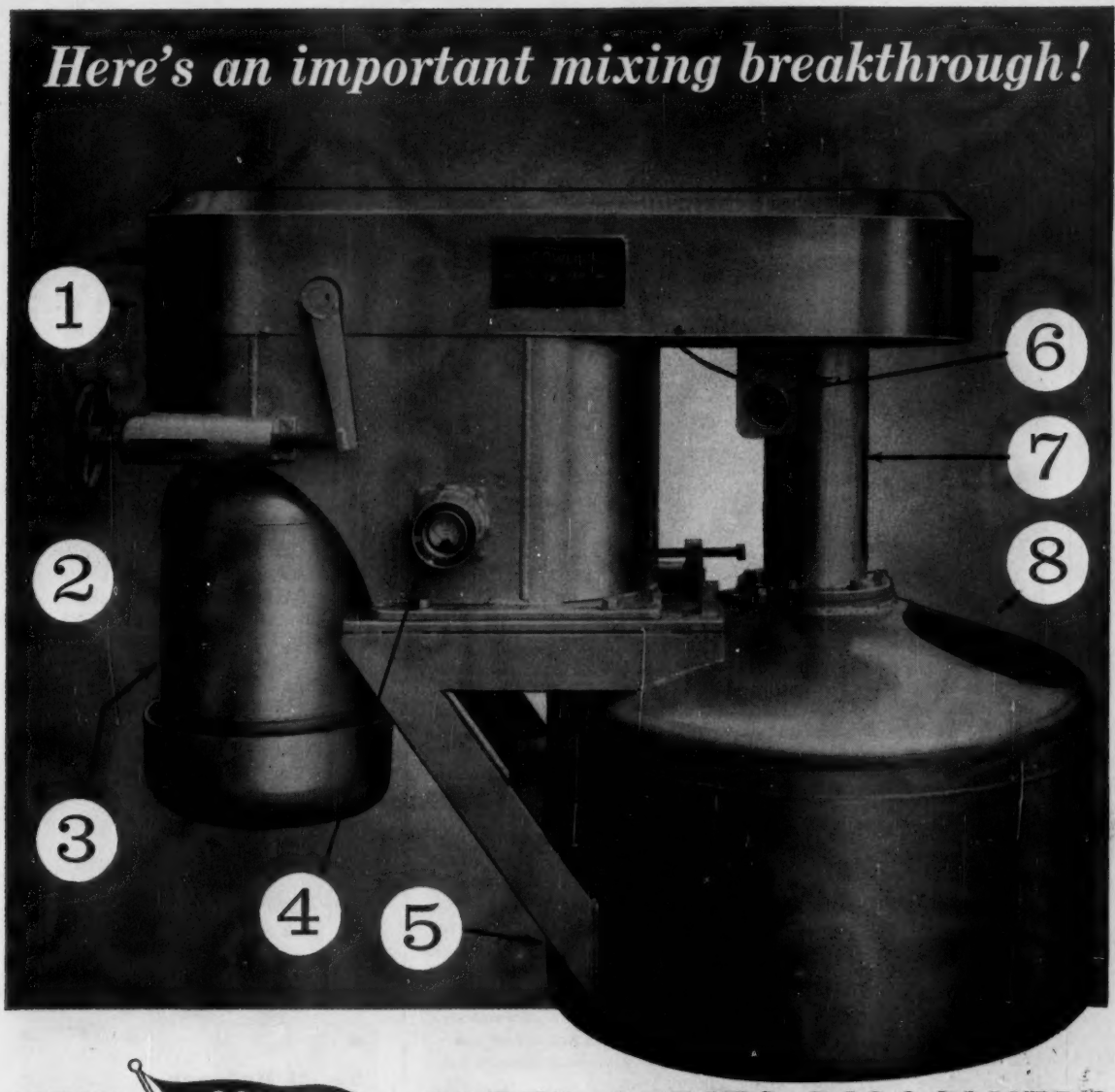
Dewpoint Recorder

Moisture content of gases measured and recorded.

Much like doctors of olden times used a mirror to test their patients' respiration, a new dewpoint recorder uses a mirror to measure the moisture content of gases.

Here's how it works: a photo-

Here's an important mixing breakthrough!



NEW COWLES SUPER SERIES DISSOLVERS PROVIDE VARIABLE SPEED, BIG-POWER MIXING IN FIXED TANKS

Now Cowles application engineers have perfected methods of adapting efficient mixing equipment to stationary tanks ...of almost any size, anywhere. If you have such problems they can very likely help you solve them. Here illustrated, for example, is the solution for one prominent chemical processor.

In this case the unit is completely leak proof—sealed against vapor loss in processing. The unique Cowles principle makes this both efficient and practical.

Special services are offered to all engineers in customizing Cowles equipment to fit their particular needs.

All units assure the characteristic advantages of Cowles Dissolvers—big volume in small space...plenty of power for all speeds...self-cleaning, non-clogging impeller...low operating costs.

Consider these features as numbered above—■ 1-Bridge assembly including MPD* *(Maximum Power Delivery)* drive system ■ 2-Variable speed adjusting wheel ■ 3-Motor ■ 4-Ammeter, integral with unit ■ 5-Fixed tank ■ 6-Tachometer, integral with unit ■ 7-Vapor-tight housing for stainless steel impeller shaft ■ 8-Vapor-tight closure in tank *(Patented stainless steel Cowles impeller in tank, not shown)*

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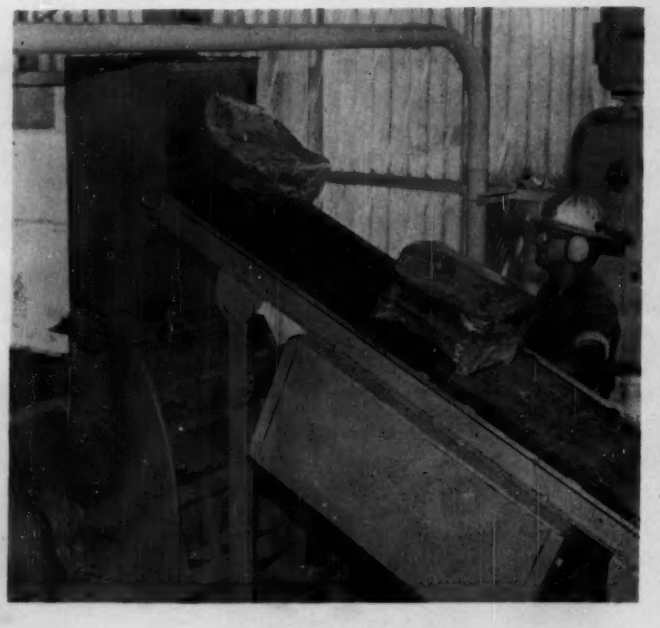


"Wood Hog" Chews Up Rubber for Research

Operators used to cut 50-lb. blocks of rubber into 5-lb. pieces to feed a small shredder at Esso Research Laboratories Baton Rouge butyl rubber pilot plant. It was slow, laborious, messy and not particularly safe work. But now a giant "wood hog" (normally used to chomp stumps and wood slabs into chips) gulps in the whole butyl block and spews out chopped bits about the size of rice grains for subsequent processing.

Rubber pellets are feed for Esso's 3-ton/day plant, which converts butyl rubber into butyl latex and halogenated products —chlorobutyl and bromobutyl. (The ear muffs are safety equipment.)—Mitts and Merrill, Saginaw, Mich. 82A

electric null system measures the size of a dew spot formed on a metallic mirror by condensation, and maintains the spot size by applying heat to the mirror. The mirror temperature is then related to the dew point, which in turn describes the moisture content.

Called the W-C Dewpoint Recorder, the instrument can be used for proportioning, on-off switching, and alarm signaling of high or low dew point. It can have either electric or pneumatic control instruments and can record on either round or strip charts.—**Weighing & Control Components, Inc., Hatboro, Pa.** 80C

Tubing Harness

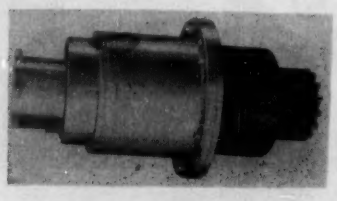
Up to 37 core tubes held within one outside cover.

Known as Poly-Cor, a new all-plastic tubing harness is said to serve at higher temperatures than have been possible previously. It is made by wrapping black polyethylene core tubes with Mylar tape, then covering everything with an extruded vinyl sheath.

According to the manufacturer, this type of construction prevents penetration by vinyl plasticizers, resists other chemical agents, keeps tubing bundle flexible and lightweight, provides protection against physical impacts.

No trial-and-error testing is needed for instrument hook-ups. Both ends of each tube are numbered in high-visibility white ink to avoid mix-ups. Telephone test-wire leads are also included in the standard tubing bundle.

Poly-Cor, with either ¼- or ⅛-in. dia. tubes, is available up to 1,000 ft., with 2 to 37 tubes per bundle.—**Samuel Moore & Co., Mantua, Ohio.** 82B



Speed Reducer

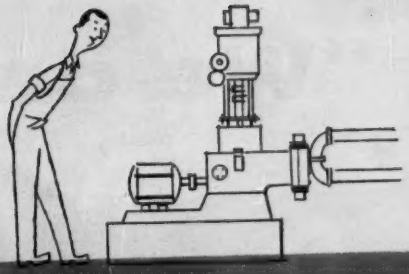
New principle of nonrigid body mechanics used.

Speed reducers and increasers, control and positioning equipment—these and other transmitting devices are now designed with a new principle of mechanics. Termed elastokinesis, the principle involves the elastic deflection of the transmission elements.

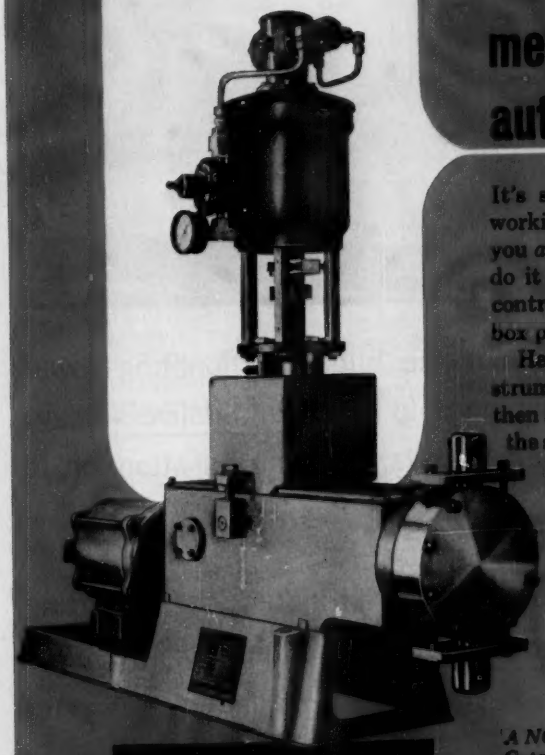
A typical drive consists of three elements—an outer rigid toothed gear, an inner flexible toothed gear and a "wave gen-

EQUIPMENT NEWS Continues on . . . Page 180

LOOK... NO HANDS!



Lapp PULSAFEEDER meters liquid flow automatically!



It's strictly hands off with automatic Pulsafeeders working in your process. These dependable pumps give you *automatically* controlled metering of liquids. They do it accurately and without resort to constant level controls, high-head tanks, measuring tanks or stuffing box pumps.

Here's how it works. A pneumatic or electronic instrument senses a change in the process condition. It then sends a signal to the Pulsafeeder, which interprets the signal and corrects its pumping rate *automatically*.

When liquids must be metered in proportion to changing process conditions—*and* in heavy production service—you can depend on the Lapp Pulsafeeder . . . the *trouble-free* automatic metering pump!

Lapp

A NOTE on your letterhead will bring you Catalog 59 quickly. This new, complete, 28-page data book is chock-full of information on applications, specifications and descriptions of Pulsafeeders of a multitude of capacities and constructions. Write today . . . Lapp Insulator Co., Inc., Process Equipment Division, 1109 Poplar Street, LeRoy, New York.

What's so special about the huge fractionating tower shown here? It is one more example of how Sun Ship builds and delivers heavy industrial equipment on barges or sea-going vessels, with careful attention to such requirements as safety and on-time schedule.

Whether it's a fractionating tower or key structural part for industry, transporting big items by water or by rail is strictly routine for Sun Ship, for we build and deliver what's needed in many fields. If you have a machinery or heavy equipment problem, write to us about it.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

CARBORUNDUM'S TECHNICAL INFORMATION ON UNUSUAL REFRACTORIES **Data sheet**

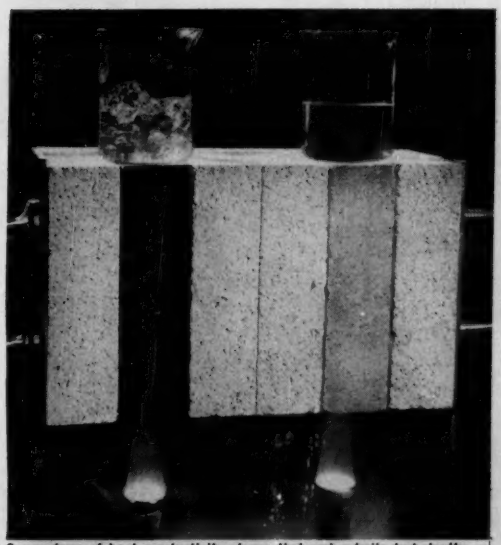
How to make use of

THERMAL CONDUCTIVITY

Although refractories are usually considered heat barriers, or insulators, some are actually excellent heat conductors. This conductivity factor can be used with advantage in many applications.

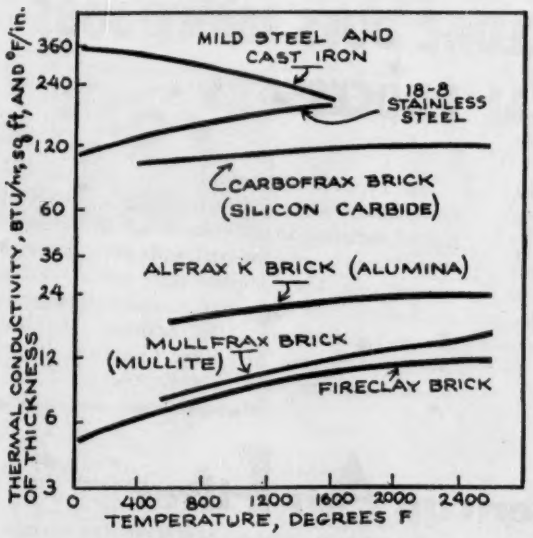
Silicon carbide refractories are among the best heat conductors known—with a heat transfer at 2200 F. roughly 11 times that of fireclay brick and 70% that of chrome-nickel steels. However, high nickel alloys lose strength rapidly above 1500 F. Silicon carbide refractories can be safely used above 2800 F. and still provide a fast rate of heat transfer.

Employed in an indirectly-heated application like a muffle, the much better heat conductivity of silicon carbide refractories can result in substantial fuel savings. For example, a silicon carbide 1½" thick wall needs a hot-face temperature of only 1571 F. to maintain a 1500 F. temperature in the work chamber. A fireclay wall of equal thickness would require a hot face temperature of 2337 F. Superior conductivity makes possible closer temperature control, particularly where conditions tend to produce wide temperature swings.



Comparison of heat conductivity shows that water boils turbulently on CARBOFRAX® silicon carbide brick; barely gets tepid on fireclay. Heat conductivity of CARBOFRAX brick is roughly 11 times that of fireclay and about 70% that of chrome-nickel steel. Thermal conductivity of CARBOFRAX brick is 109/Btu hr., sq. ft. and °F/in. of thickness.

The chart at left shows thermal conductivity of various Carborundum refractories—including silicon carbide, alumina, and mullite—as opposed to metals and fireclay brick. For the refractory best suited to your particular application, feel free to call on Carborundum's accumulated experience.

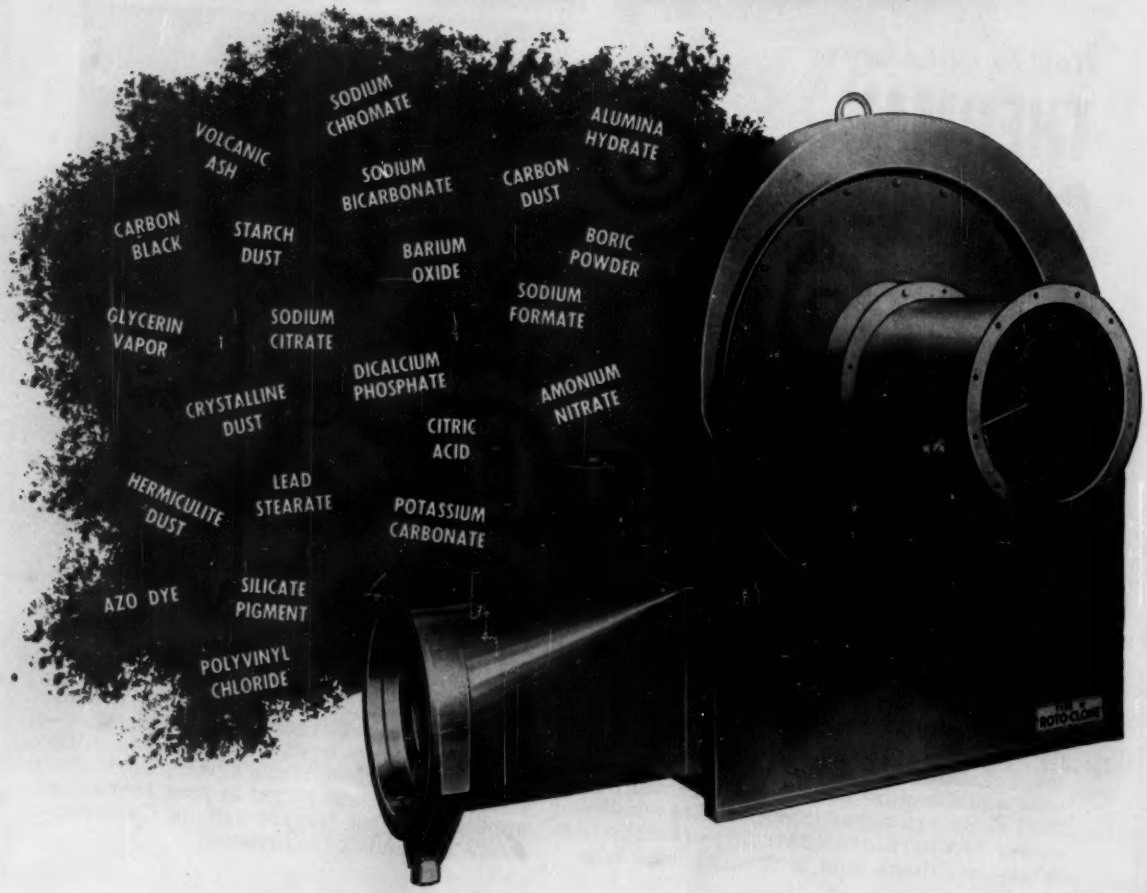


Coefficients of thermal conductivity for some of Carborundum's refractories and other materials at different mean temperatures. Information adapted from Figure 4, Carborundum "Refractories" Vol. 3, No. 5, December 1958. This bulletin, containing extensive technical information on the properties and applications of refractory-type products, is published bi-monthly. A request will put you on the mailing list.

Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. H-90, Refractories Division, Perth Amboy, N. J.

For engineered refractories, count on **CARBORUNDUM®**

Do you have a DUST PROBLEM?



AAF TYPE W ROTO-CLONE DOES MANY JOBS FOR CHEMICAL PROCESSORS

If your operations require collection of fine dust particles in moderate concentrations, you've got a job for the AAF Type W ROTO-CLONE.

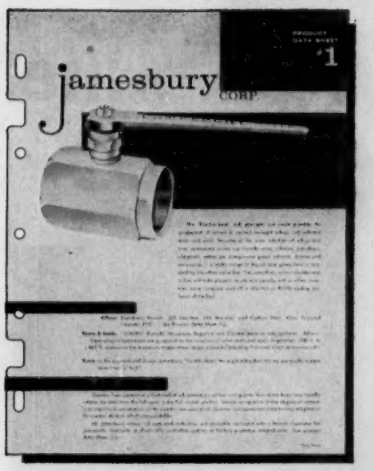
The ingenious addition of water sprays extends the effectiveness of this dynamic precipitator to collection of the finest, lightest dust particles. The compact Type W ROTO-CLONE provides everything you need, except duct connections, in one complete shop-assembled package.

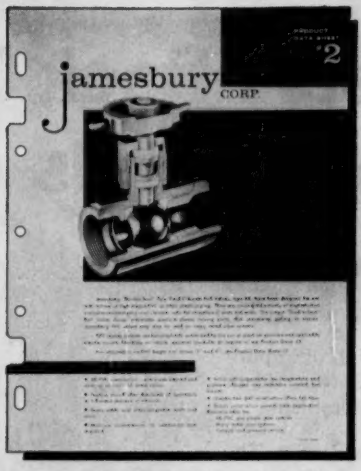
The Type W requires little maintenance, uses a minimum of water and maintains efficiency regardless of variation in air volume. It can be made of special metals or protected with most coatings at modest cost. For complete information, call your local American Air Filter representative or write direct for Bulletin 272B. Address: Mr. Robert Moore, American Air Filter Company, Inc., 326 Central Avenue, Louisville, Kentucky.

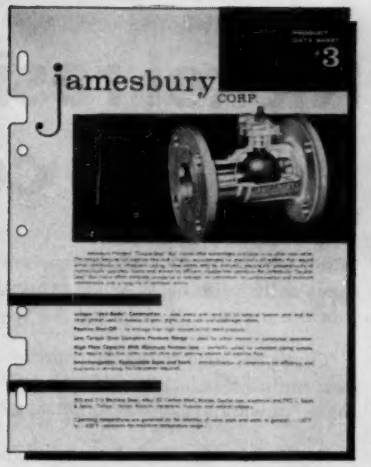
AAF American Air Filter

BETTER AIR IS OUR BUSINESS

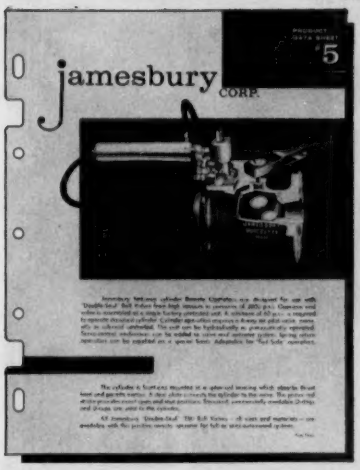
Yours For The Asking!

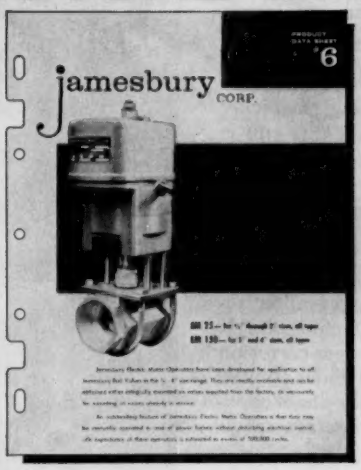


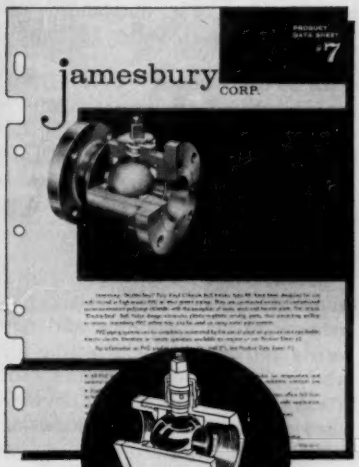


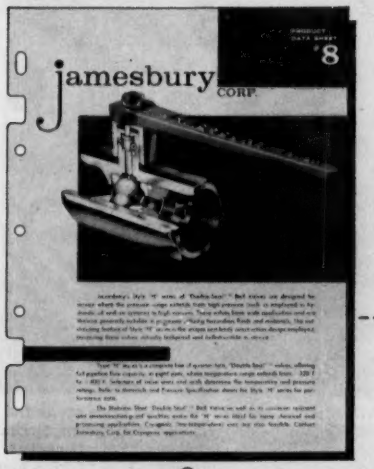


FACTUAL DATA









"Double-Seal"

on Jamesbury BALL VALVES

AS VERSATILE AS INDUSTRY ITSELF

Get the full story on Jamesbury Corp.'s complete line of "Double-Seal" Ball Valves and accessories. Learn why the Jamesbury "Double-Seal" Ball Valve has been labeled "as versatile as industry itself". Get all the facts on materials, sizes, etc. They are yours for the asking: the facts about Jamesbury Corp. — the nation's foremost exclusive manufacturer of Ball Valves.

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NEW STREET, DEPT. PDS, WORCESTER, MASS.
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JAMESBURY BALL VALVES
HELPING BUILD OUR NUCLEAR NAVY

In production of high-purity thorium...

Nickel resists attack by chlorine and its compounds at 400° C

When you start with crude thorium tetrachloride, it takes a little doing to wind up with a high quality thorium metal.

That's because crude thorium tet is full of impurities, metallic chlorides HCl and Cl_2. Getting rid of these "unwanteds" poses something of a problem.

Here's how the U. S. Bureau of Mines does it. The thorium tet is first volatilized at 800°C, then condensed at 400°C. Nickel is used as the condenser material because of its outstanding resistance to attack by hot metallic chlorides, HCl and Cl_2.

In 16 to 20 hours, a 10-kilogram batch of thorium tet is completely volatilized. After cooling, the nickel condenser is removed from the furnace. One end is placed in a plastic bag filled with argon, and is rapped with a mallet to dislodge the crystalline tetrachloride. Thorium tet is later reduced with sodium to yield the high-purity metal.

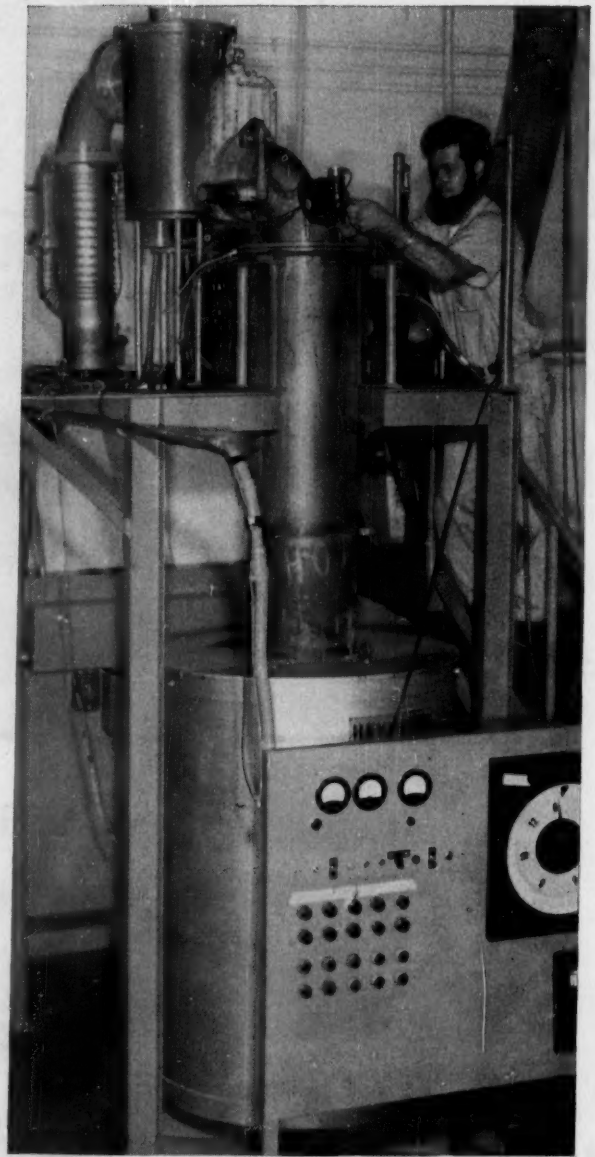
Nickel offers many advantages for handling chlorine and chlorine compounds. It displays excellent resistance to acid, alkaline and neutral chlorides. It resists corrosive attack, pitting and stress-corrosion cracking in chloride solutions, stands up under applied stress, alternate wetting and drying, vapor phase exposure, and even drastic conditions of temperature, agitation and aeration.

Low maintenance, too. Because of its high resistance to destructive conditions, nickel equipment usually requires only a minimum of maintenance attention. Its use puts you in line to attain some long-range economies.

And good workability. Nickel is readily formed and welded. Welded seams are just as strong and corrosion-resisting as the metal itself, and require no heat treatment after fabrication to produce maximum properties.

For further information on the uses of Nickel for handling chlorine and chlorine compounds — or for help in selecting materials to meet a specific need — write us.

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

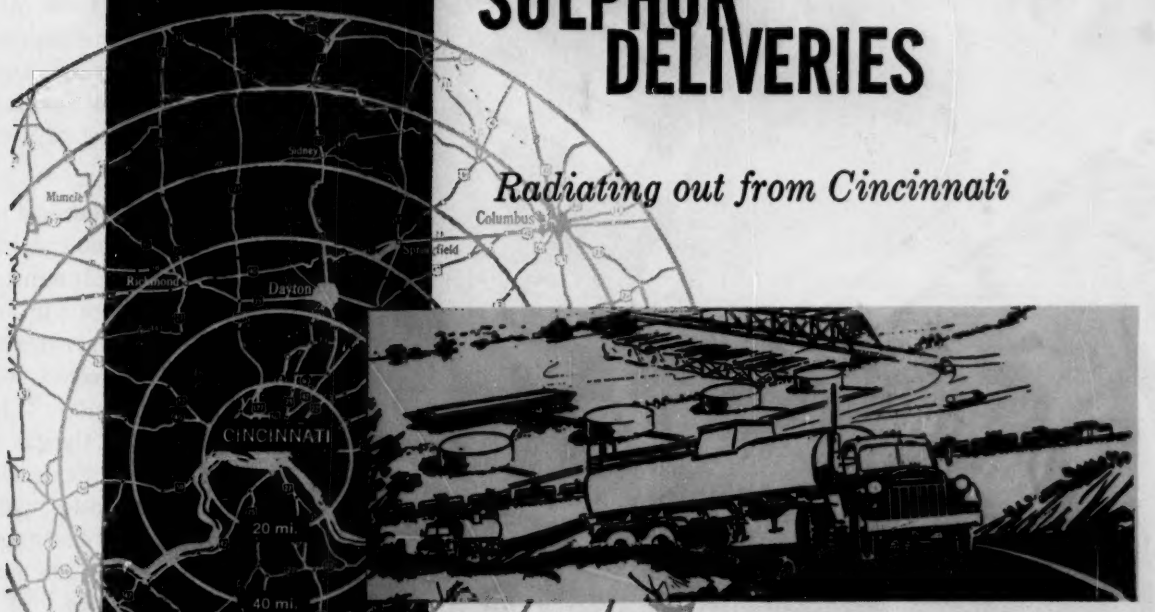


PURIFICATION FURNACE. Impurities are removed from crude thorium tetrachloride by high-temperature vacuum distillation carried out in a retort. The retort is fitted with a nickel condenser. Nickel was selected because of its resistance to metallic chlorides, chlorine and hydrogen chloride. *Photo courtesy U.S. Bureau of Mines, Albany, Ore.*

NICKEL

NOW.... PROMPT MOLTEN SULPHUR DELIVERIES

Radiating out from Cincinnati



This is the first of the TGS Terminal Molten Sulphur Truck and Rail Distribution Stations being set up to serve industrial areas of the country. Regular large tonnage barge shipments of Molten Sulphur from our mines in the Gulf area are keeping this Cincinnati Terminal well-stocked to meet the growing demand for Molten Sulphur in the Ohio River area.

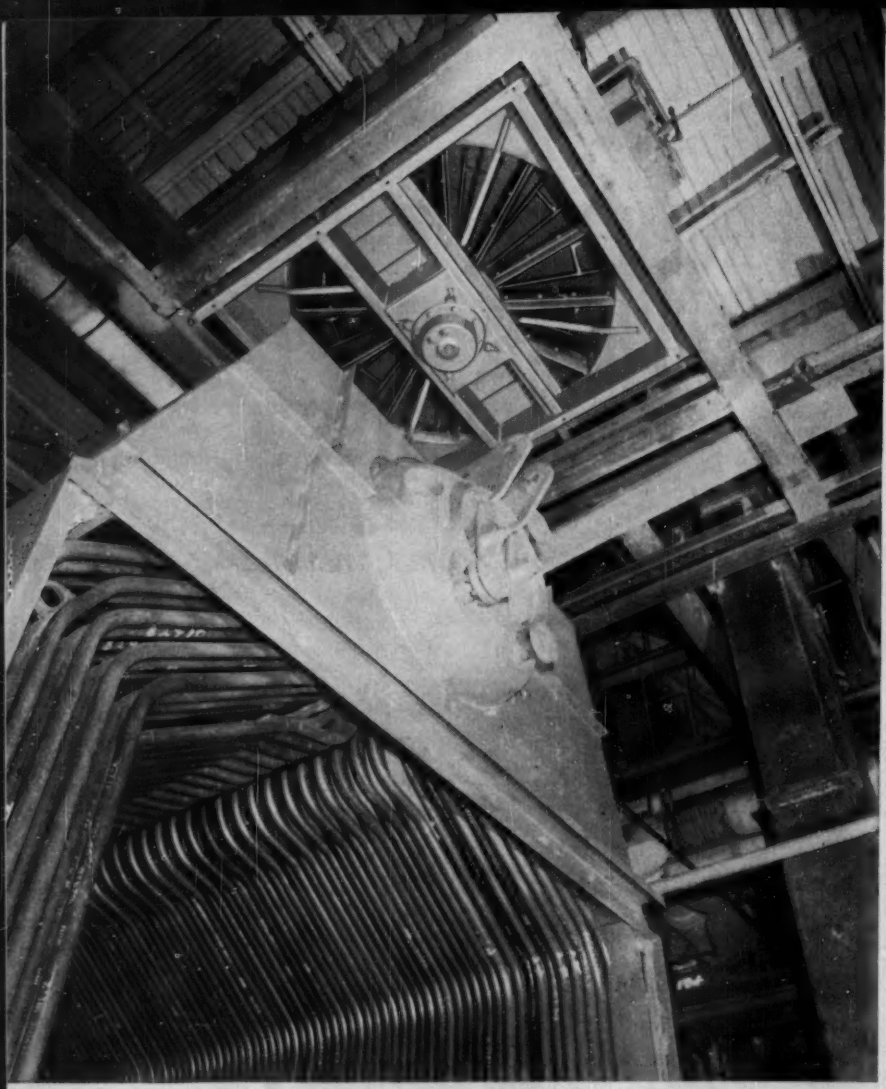
Additional Molten as well as Solid Sulphur terminals are being considered for other parts of the country.

TEXAS GULF SULPHUR COMPANY

75 East 45th St., New York 17, N. Y. / 811 Rusk Ave., Houston 2, Texas

Sulphur Producing Units: Newgulf, Texas • Spindletop, Texas • Moss Bluff, Texas • Fannett, Texas • Worland, Wyoming • Okotoks, Alberta, Canada

Molten Sulphur in tank *cars* can be delivered to any point in the States or Canada from our nearest mine or recovery plant. Barge deliveries of Molten Sulphur are available on all navigable inland waters. Solid Sulphur, as for many years, is deliverable all over the world. Large inventories at our mines assure industry it will get its supplies when needed.



The Ljungstrom Air Preheater at the B. F. Goodrich Company Shelton Plant is installed directly over the 65,000 lb/hr Wickes boiler. Flue gas leaving the boiler at 615°F passes through the circular rotor, which absorbs the heat and releases it into the incoming air. Preheated combustion air improves combustion, makes fuel burn cleanly. This Package Air Preheater was factory-assembled, and requird only 100 manhours to install.

At B. F. Goodrich Co.'s Shelton Plant

Air Preheater boosts combustion air temperature 345°F... gives 6% more thermal efficiency

"Only a Ljungstrom® Air Preheater, with its continuous regenerative principle, could meet our requirements", says A. G. Sandomirsky, Manager of Engineering at the B. F. Goodrich Company, Shelton, Conn., plant. "We produce foam rubber 24 hours a day, five and six days a week. With an Air Preheater we can meet process steam requirements more economically, and an Air Preheater helped us to justify the installation of high efficiency, high pressure equipment for by-product power generation."

Here's why the Shelton plant meets its requirements best with a Ljungstrom Air Preheater:

1. Ljungstrom is the most efficient heat exchanger you can buy. The Ljungstrom rotor revolves continuously through the flue gas and incoming air, thus absorbing heat and releasing it *from the same surface*. Since the heat doesn't have to pass through anything, each inch of rotor surface is as efficient as one foot of a tubular recuperator.

2. Ljungstrom is the most reliable heat exchanger you can buy. All heat exchange elements pass through the entire air and gas streams. The temperature of the elements in the coolest region – where fresh air enters – is actually an average of the gas and air temperatures, so it's consistently higher than the coolest point in a recuperative heat exchanger. Result: no cold spots, less chance of moisture formation.

3. Ljungstrom is easiest to maintain. You can inspect it – and clean it–while it's running. Heat exchange elements are divided into modular baskets that can be replaced individually without disturbing the other elements. You can even reverse the elements if the surface has thinned on one edge, effectively doubling the life of the heat exchange surface.

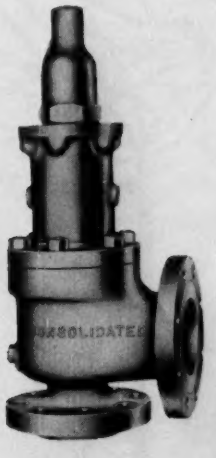
For more information on the Ljungstrom continuous regenerative principle, or on the Air Preheater that meets your requirements, phone MUrray Hill 2-8250 or write to The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

top

CONSOLIDATED SAFETY RELIEF VALVES have a special "O" Ring Seat Seal that stops leakage completely



Consolidated Safety Relief Valves are available in both Standard and Balanced Bellows design for extreme corrosive applications.

tightness

The Seal is a resilient ring set in the valve disc. It maintains no-leak tightness by contact with a specially curved seating surface on the valve nozzle, yet does not carry the seat load imposed by the valve spring.

Tightness is maintained at operating pressures far closer to set pressure than with metal-to-metal seats alone. Tight closure is as efficient after "simmer" as on normal blowdown. Piping strains are absorbed far better by the resilient seal than all-metal seating. If the tough seal is ruined by entrained abrasives, replacement is easy. Seals are available in materials that resist corrosive fluids. Maintenance costs are greatly reduced.

Standard Consolidated Safety Relief Valves have an eductor tube that removes pressure from the closed bonnet. Only the spring controls valve action. You get guaranteed capacity ratings and highest dependability—absolute protection for personnel and equipment. Additionally, there is the economy of converting the Standard valve to the Balanced Bellows type in your own shop. Get complete details. Write for Bulletin 1940.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

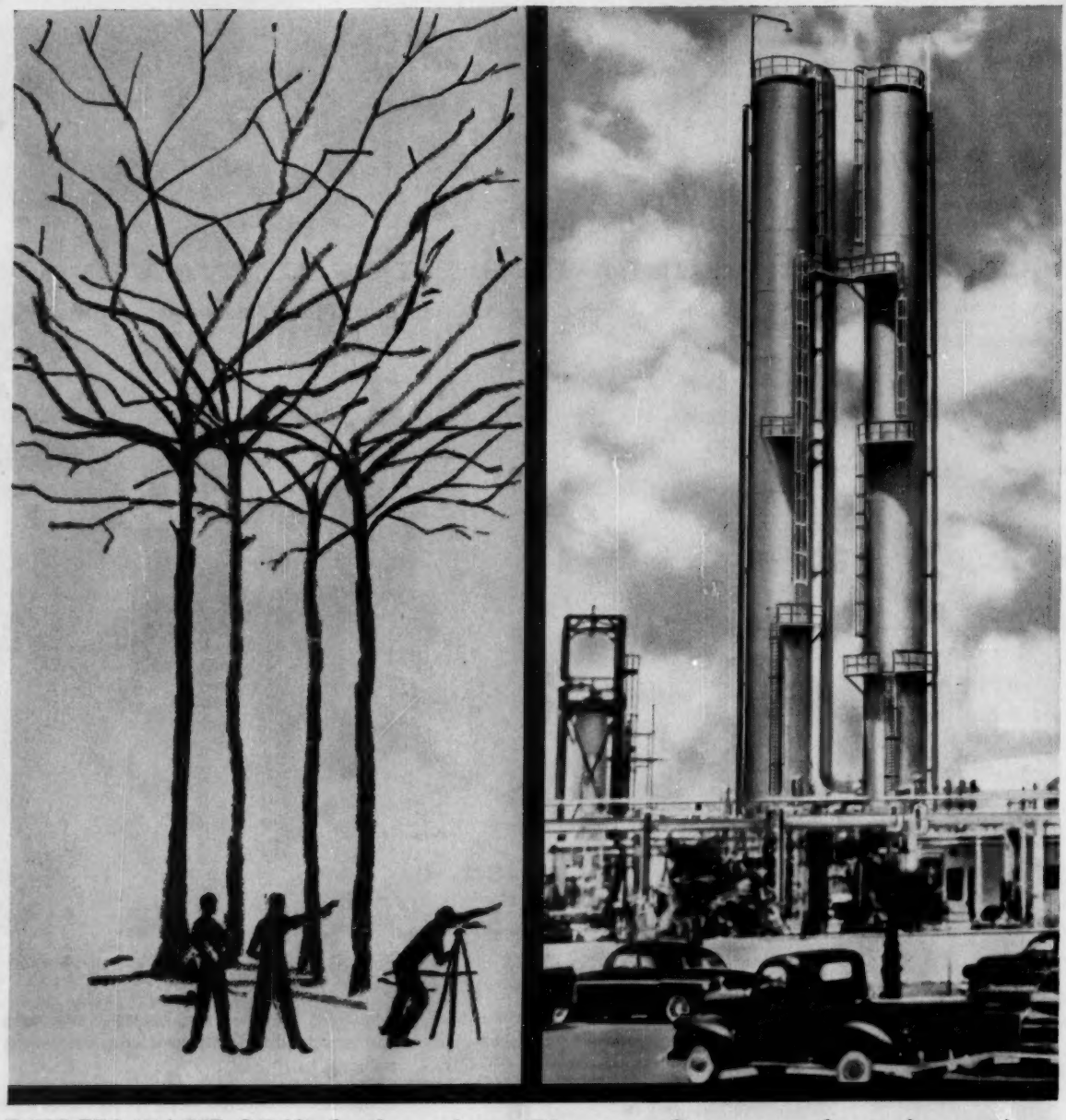
CONSOLIDATED SAFETY RELIEF VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Tulsa, Oklahoma

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario



DELHI-TAYLOR'S Orthoxylene Plant on Stream...from inception to completion in **only 6 months**

Once again Delhi-Taylor has proved its reputation for performance . . . this time with the quick completion of its new orthoxylene plant to meet customer needs. The engineering survey was begun in January and material was processed on June 15! This is Delhi flexibility in action . . . its unique ability to expand into new petrochemicals with a minimum of delay.

■ The two 160 ft. high distillation towers, which feature unique plate design and arrangement, will be used primarily to produce high purity orthoxylene. The plant is designed so that other chemicals can be derived from the company's diversified petroleum and petrochemical feedstocks.

■ Delhi is now in production on high purity benzene, toluene, xylene, orthoxylene, higher boiling aromatics and a variety of aliphatic solvents. Our plant facilities are geared to move quickly in many new directions.

CHEMICAL DIVISION

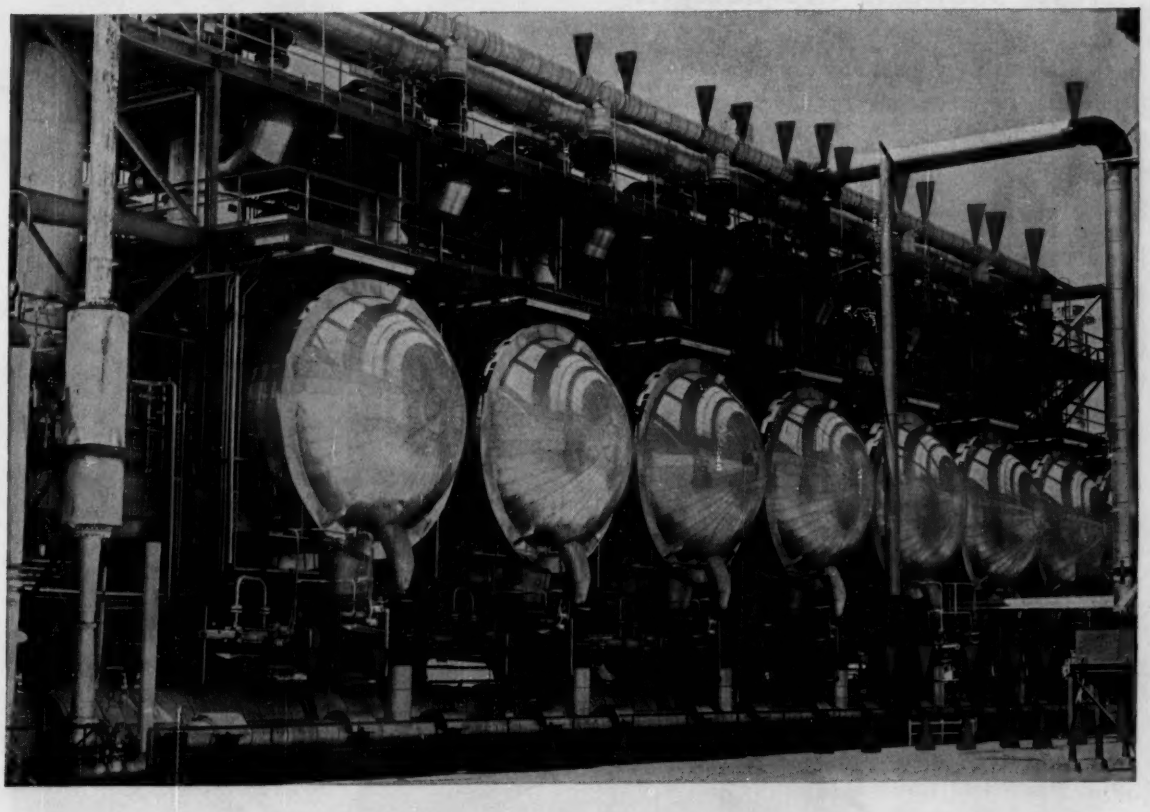
DELHI-TAYLOR OIL CORPORATION

FIDELITY UNION TOWER, DALLAS 1, TEXAS • 415 MADISON AVE., NEW YORK 17, N. Y.
CORPUS CHRISTI • CHICAGO • CHARLESTON, S. C. • BATON ROUGE • HOUSTON

85½ in. dia. expansion joint connecting quench and pre-quench towers. Pinned structural ties permit expansion joint to absorb axial and differential vertical movement.

48 in. dia. expansion joint at compressor discharge. Double bellows permit large axial movement. Internal sleeve guide provides for stability, minimum pressure drop.

54 in. dia. hinged expansion joints in loop to pre-quench tower. They absorb 5⅜ in. vertical expansion and 7⅛ in. horizontal expansion due to 1200°F temperature in reactor header.



125 ZALLEA EXPANSION JOINTS, 125 demands for maximum reliability

Expansion joints, specially engineered and designed by Zallea, solve problems of space, heat and flow for Odessa Butadiene Co., Odessa, Texas.

Large-diameter piping (up to 72 in. dia.), with short, straight runs and critical flow conditions, posed new design problems. High temperature operation (1200°F) required minimum loading on sensitive equipment. Open-air construction, with few load carrying members dictated maximum stability of expansion joints with minimum use of external guides and anchors to support pipe weight and resist wind loading.

To solve these problems called for a competent, close-working team of process, piping and structural engineers from Fluor Corp. Ltd., design engineers from Odessa Butadiene Co., and application engineers from Zallea.

Result: A compact, reliable piping-expansion joint system that permitted containment of an efficient, 50,000 ton per year unit in an area whose largest dimension is a few hundred feet.

This is another example of how Zallea experience in handling critical, complex Expansion Joint applications can save time and money. For more facts, call us . . . or write for catalog 56.

ZALLEA BROTHERS, Taylor and Locust Sts., Wilmington 99, Del.

Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

Do you check these points When Buying **STAINLESS STEEL** *Valves?*

- ☐ **How good are the castings?**
- ☐ **How precise is the machining?**
- ☐ **How rigid are the inspection and testing?**
- ☐ **How sound is the design?**

Just as important as a suitable stainless steel alloy are these four checks on valve quality. For long, dependable performance, a valve should rate *perfect* on every one.

There's a very good reason why you can be sure Jenkins Stainless Steel Valves will do that, unvaryingly:

For almost a century Jenkins has specialized in making valves. And making them to one standard of quality . . . the highest. Every operation and every worker is aimed at fulfilling that standard. The result is a product that can be backed by this 91-year-old assurance for valve users:

A Fair Offer

If you will put a Jenkins Valve, recommended for your particular service, on the worst place you can find . . . where you cannot keep other valves tight — and if it is not perfectly tight or it does not hold steam, oil, acids, water or other fluids longer than any other valve, you may return it and your money will be refunded.

Order these reliable Jenkins Valves from your local Jenkins Distributor. Ask him or write us for Stainless Steel Catalog No. 59SS. Jenkins Bros., 100 Park Avenue, New York 17.

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864 Jenkins Bros

Sold Through Leading Distributors Everywhere

News from
National Carbon Company
Division of Union Carbide Corporation . 270 Park Avenue, New York 17, New York
In Canada: Union Carbide Canada Limited, Toronto

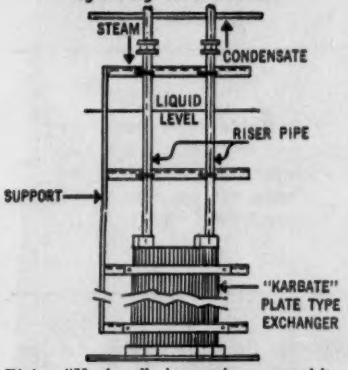
Manager Activated Carbon

H. B. Allport

Mr. Allport was graduated from Case Institute of Technology with a B.S. in Chemical Engineering. He joined National Carbon Company in 1943. Much of his early work in the Chemical Products Group was devoted to designing and improving existing designs of "Karbate" impervious graphite equipment for use in the Chemical Process Industry.

From 1947 to 1950 Mr. Allport was a district engineer in National Carbon Company's Pittsburgh Sales Office. In 1956 he was appointed Manager, Activated Carbon, Chemical Products Marketing.

"Karbate" Plate Heater Installation Reduces Process Cycle by five hours.



Eight "Karbate" impervious graphite plate heaters are used by a plant turning out phospho-organic intermediates for pesticides manufacture. These units (which replaced eight alloy units) are handling a mixture of phosphoric and hydrochloric acid plus organic materials.

With the installation of eight "Karbate" impervious graphite plate heaters the user was able to reduce the production cycle in this application from 19 to 14 hours. It is expected that a modification of the steam piping arrangement will make further savings possible.

"KARBATE" IMPERVIOUS GRAPHITE HEAT EXCHANGERS COMBINE LONG LIFE, CORROSION RESISTANCE AND LOW MAINTENANCE

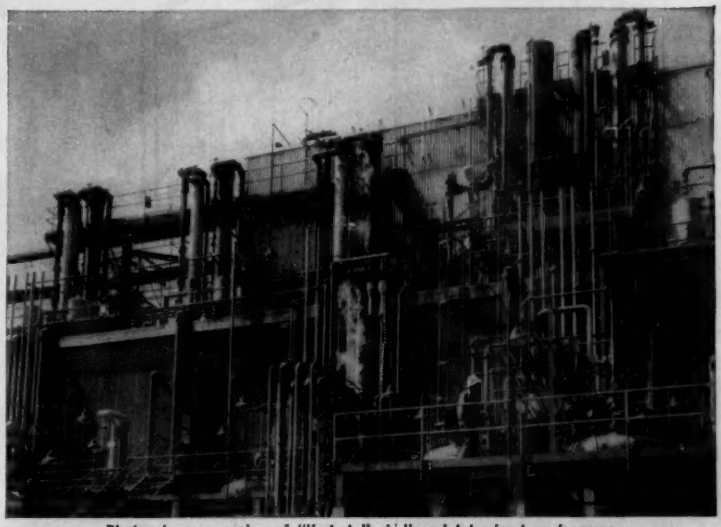


Photo shows a series of "Karbate" shell and tube heat exchangers condensing acid — containing vapors in an organic chemicals plant.

LONG LIFE — "Karbate" Condensers Last 5½ Years Longer Than Metal Units in a Tough Corrosive Service.

The unsurpassed corrosion resistance of "Karbate" impervious graphite makes it an excellent material of construction for shell and tube condensers handling corrosives on both sides. In this service, propylene dichloride with traces of HCl was condensed on the shell side using sea water as the coolant on the tube side.

The condensers have been operating for six years with little maintenance. Metal units in the same service have to be re-tubed about every six months because of excessive corrosion on the active condensing surfaces.

CORROSION RESISTANCE—One "Karbate" Exchanger Does the Work of Two Metal Units.

The absence of corrosion products enabled a single 1,290 square foot "Karbate" impervious graphite exchanger to handle the same heat transfer as two steel units each of equivalent area. After one year in a brine cooling application, the steel units accumulated excessive amounts of rust and mud which impaired their heat transfer. Inspection of the "Karbate" impervious graphite unit after a similar time, showed the tubes to be "clean as a whistle" on both sides.

LOW MAINTENANCE — Ten Years of Trouble-free Service Concentrating H_3PO_4.

Two 110-tube heat exchangers show the low maintenance advantages of "Karbate" impervious graphite material. These units have provided ten years of service concentrating phosphoric acid from 20% to 75%.

Outside of an occasional cleaning, the user says, these units have required little maintenance over this ten year period.

NATIONAL TRADE-MARK

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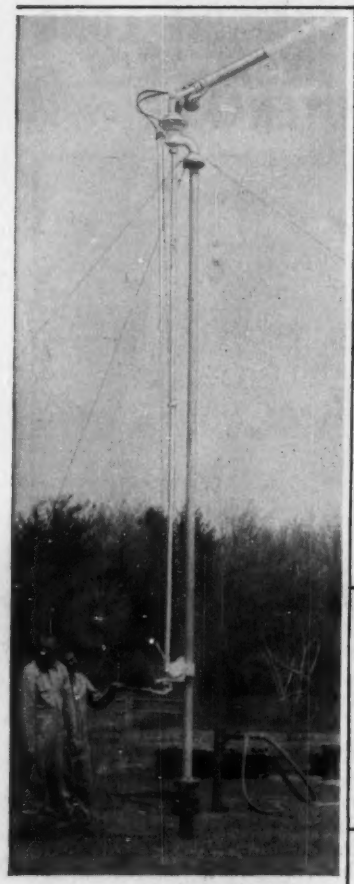
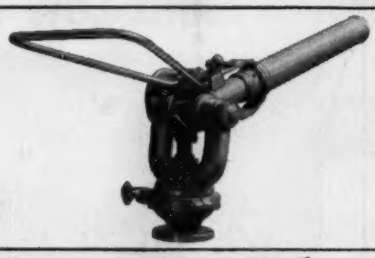
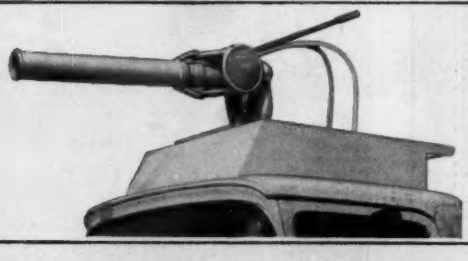
...All Rockwood Turrets Discharge FogFOAM
Solid FOAM Stream — WaterFOG — Solid Water Stream



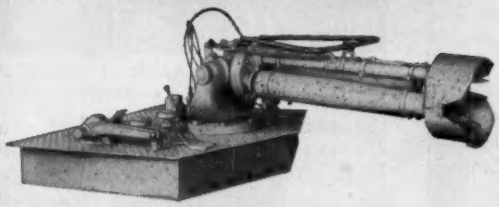
Extended Manual Control Type — Turret nozzles extend 10 to 20 feet above remote control station on deck or ground on standard units ... greater remote extensions for special applications.



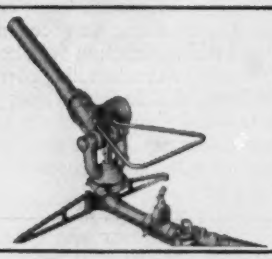
Direct Manual Control Type — Gives fire fighters "out-in-the-open" control from cab roof!



Remote Manual Control Type — Easily handled by man in driver's seat. Ideal for fast action!



Remote Hydraulic Control Type — Power-controlled from within the cab. Single and dual models. Widely used on air crash rescue fire-fighting trucks.



Portable Type — Off the truck and into action in seconds! Goes wherever a fire fighter can bring the proper hose line into action!

On the truck or on the ground, fire fighters can hit fires *harder* using ROCKWOOD Turrets! At airports and refineries ... in municipalities and throughout industry ... these advanced-design fire-fighting aids are constantly proving their ability to extinguish fires faster.

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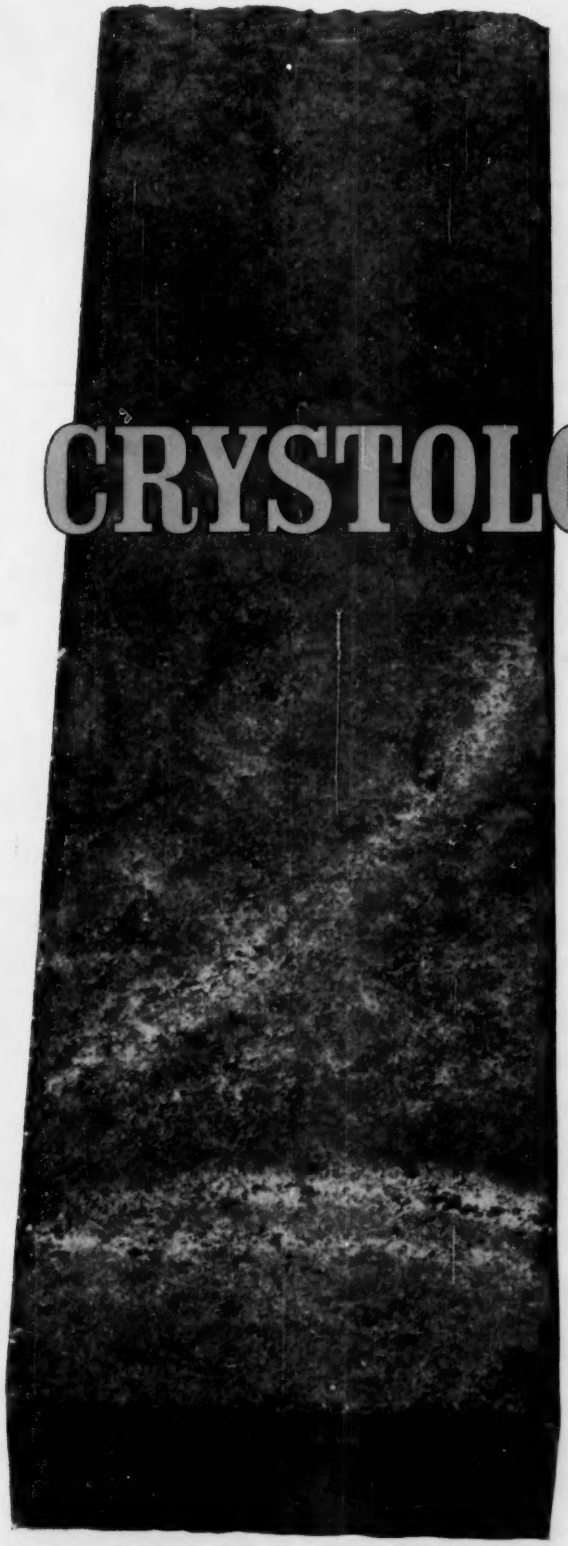

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Produced by an exclusive Norton process, CRYSTOLON "63" silicon carbide provides all the superior properties of nitride-bonded silicon carbide at a *new low cost!* It has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. In extensive tests, it not only showed excellent resistance to "wetting" by molten nonferrous metals (aluminum, magnesium, zinc, lead and others) but also to fused salts, such as cryolite!

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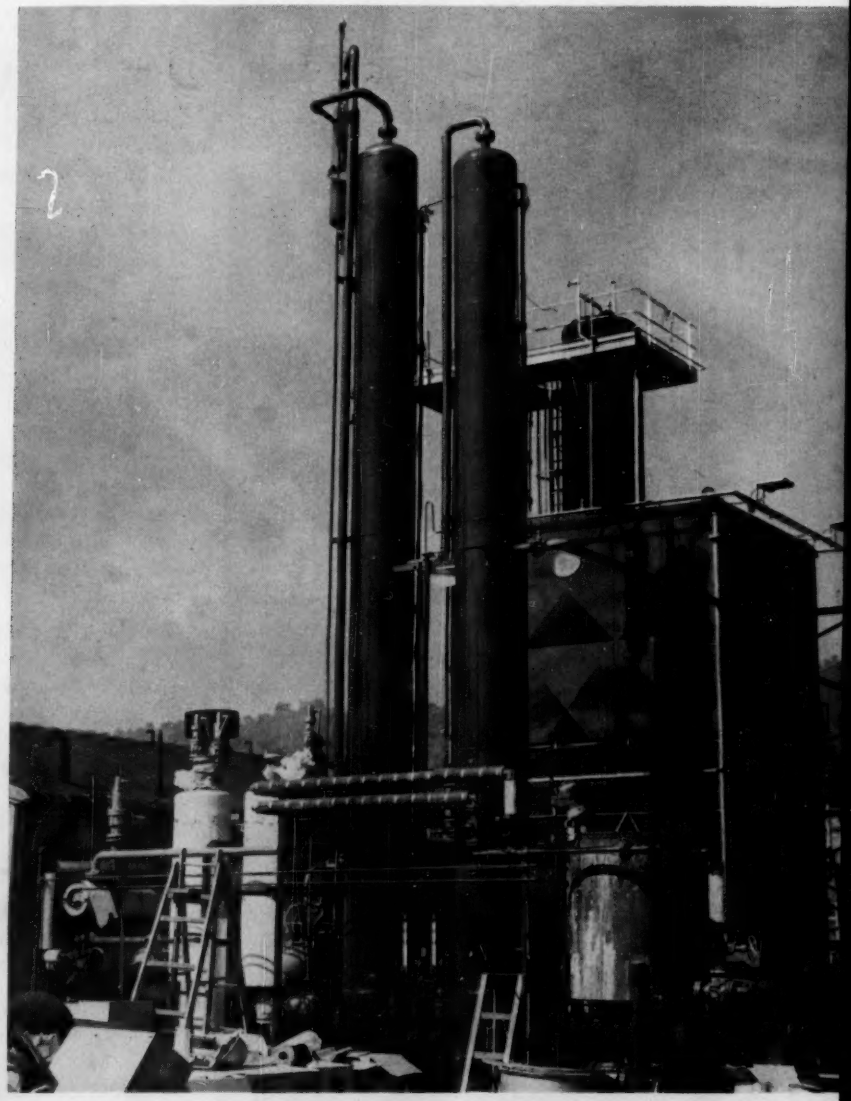
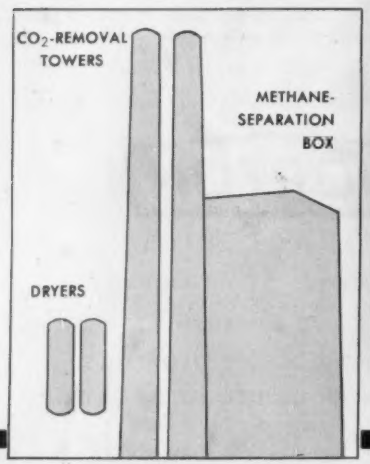
Process Flowsheet

Cryogenics Moves in on Methane

New, highly automated unit takes natural gas feed, flashes and fractionates it at low temperature to yield 99.99+%-pure methane for making chlorinated hydrocarbons.



COLD-BOX, heart of the methane unit, separates gas mixture after stream has been scrubbed, dried.



Unfold Flowsheet

A cryogenic process that makes 99.99+%-pure methane is a Johnny-come-lately addition to the long-established family of techniques for producing high-purity gases by low-temperature fractionation. The methane process, which dates back to 1955, made its latest appearance several weeks ago when a brand-new 500-cu. ft./min. unit for purifying methane-rich natural gas went on stream at the Moundsville, W. Va., plant of Allied Chemical Corp.'s Solvay Process Div.

Low-temperature methane purification is probably unique among cryogenic gas processes because the methane product is used solely as raw material for chemicals manufacture. Output of the new unit at Moundsville, like that of similar methane plants, is used as feedstock for making chlorinated hydrocarbons —carbon tetrachloride, chloroform, methylene chloride and methyl chloride.

► **Narrow but Rewarding** — Although the methane units have found themselves only this narrow niche, they can reap high dividends—stemming from the extreme purity of the methane product—for companies in the chlorinated-hydrocarbon business. Older methane purification routes include adsorption at ambient temperature (which Solvay formerly used at Moundsville) and absorption in oil at about −40 F.; these methods yield product streams having impurity levels of 5,000-12,000 ppm. and 1,000-2,000 ppm., respectively. The new cryogenic process, on the other hand, can yield methane having less than 100 ppm. impurities.

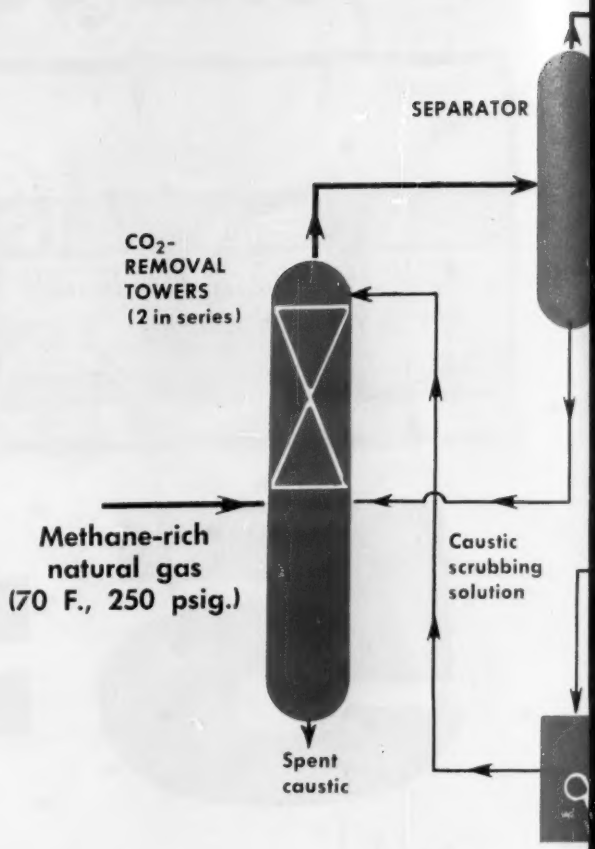
Main advantage of high-purity material is low ethane content. When a methane stream undergoes chlorination, any ethane present also becomes chlorinated. The chlorinated ethanes do not merely dilute the desired methyl product; they are chemically unstable and decompose to form HCl, thus creating a corrosion problem. So, a high-purity methane feedstock helps a manufacturer of chlorinated products by yielding him a purer product and also by saving his processing equipment.

► **Predecessors**—Two firms—Air Products, Inc., and American Air Liquide, Inc.—have designed and built low-temperature units to purify methane. Solvay's new Moundsville installation was made by Air Products, as was a similar facility that Diamond Alkali Co. operates at its Belle, W. Va., plant. The Air Liquide version of the process is represented in a Frontier Chemical Co. plant at Wichita, Kan., and in a Louisville, Ky., plant of Stauffer Chemical Co.

► **Features**—While Air Products discusses costs of its plant very guardedly—saying only that the price tag for the Moundsville unit read something less than $500,000—the firm readily points out several attractive operating features of the plant it shipped to Moundsville.

In the first place, the facility boasts a high degree of automation. Once it is on stream, it can be run with only part-time attention from one operator. Another feature anticipated is good reliability: Air Products anticipates that the unit will require only about 1% downtime for maintenance. Heart of the plant is enclosed in a large, insulated box, and the box theoretically will never need be opened for repairs or maintenance if the unit is operated correctly. Further, the plant will run for a full year, claims Air Products, before requiring shutdown for defrosting.

Special heat exchangers make up an unusual aspect of the unit. Rather than using conventional exchangers such as the shell-and-tube variety, Air Products has equipped the facility with "coiled" exchangers that consist of numerous parallel paths of small-diameter metal tubing mounted in an ordinary shell-side cavity.

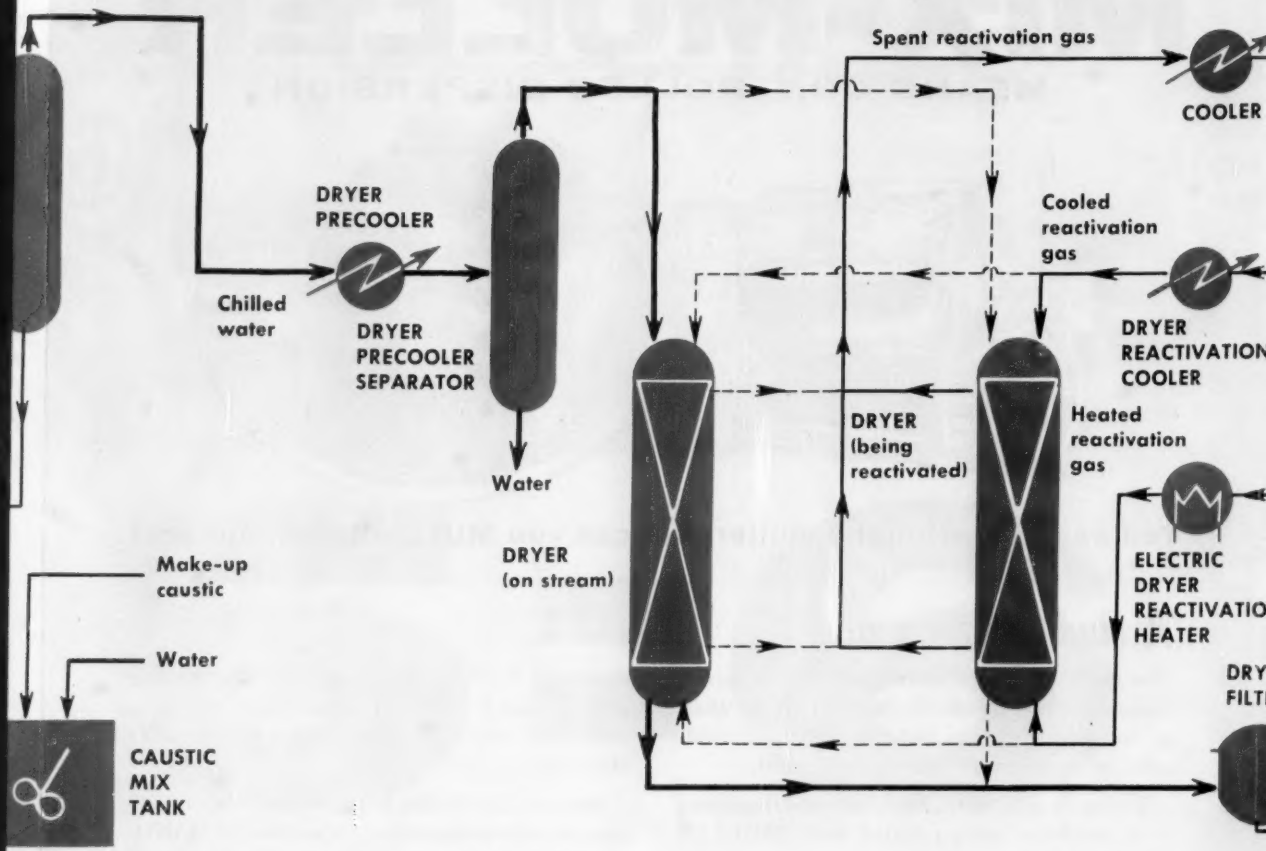


► **Feed**—Solvay feeds methane-rich natural gas to its new Moundsville unit. The gas has been pretreated to remove hexane and higher hydrocarbons, and methane content as it enters the facility is about 90%. Maximum levels for other components include 8% ethane, 2% propane, 0.15% butanes and heavier hydrocarbons, and 800 ppm. CO_2, 500 ppm. water and 5 ppm. H_2S.

Entering at 250 psig. and 70 F., the mixture first passes through two 2-ft.-dia. by 25-ft.-high towers connected in series, where a caustic scrub removes CO_2. Spent caustic is not regenerated; it leaves the unit, goes to other Solvay processes nearby.

Gas stream is next cooled in exchangers, then dried by contact with alumina desiccant. The unit is equipped with two drying towers arranged in parallel, so that alumina in one tower can be reactivated while the other tower continues to dry the process stream. Methane-depleted gas is used as reactivating medium.

The dried gas passes through a filter that removes dust, then is ready to enter the cold-box that houses the actual methane-separation equipment.



▶ **The Box**—Gas stream entering the box is first cooled by heat exchange with exiting methane product and depleted gas. The cooled stream then passes through an expansion valve, dropping in pressure from 245 to 85 psig., and enters a column where flashing and fractionation yield methane at —205 F. as overhead product.

This overhead stream is split into two parts. One part constitutes the plant product stream, and the other part is used as recycle to furnish refrigeration and reflux for the column.

The recycle portion is compressed, then passed through adsorption towers that remove any oil introduced during compression. En route to the compressor, the stream passes through a heat exchanger where it cools the compressed stream returning from the oil adsorbers.

The latter stream is then cooled further by heat exchange with the plant-product portion of the column overhead. After this second cooling step, the gas drops from 3,000 psig. to 100 psig. by passing through an expansion valve into a phase separator. This expansion furnishes the bulk of refrigeration for the entire separation process; the cold liquid that forms in the bottom of the phase separator is introduced to the top of the column as reflux, and the gas from the separator is combined with the column overhead.

The plant-product portion of the column overhead first cools the recycle stream, as described above, then helps to cool feed entering the box. Finally, it is heated by steam to a specified temperature of at least 60 F.

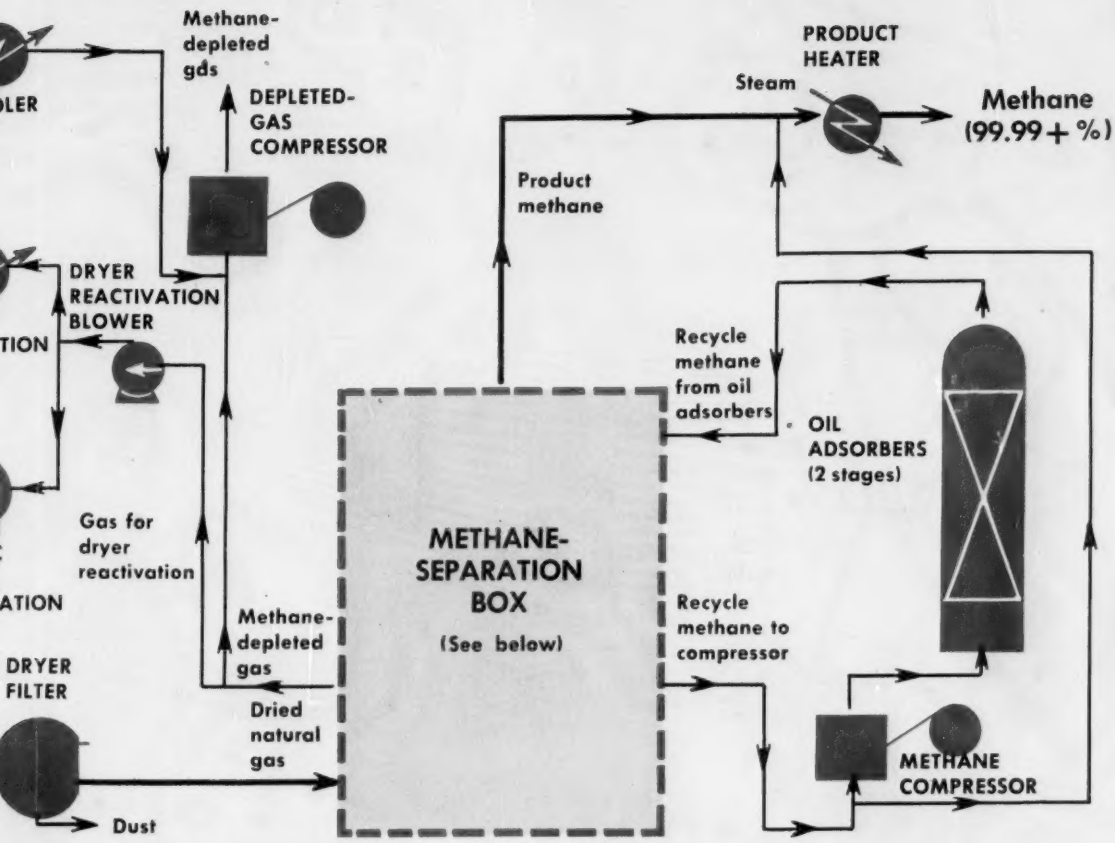
Part of the reflux stream may also be tapped off as plant product. When this is done, the gas that is taken is also passed through the steam heater.

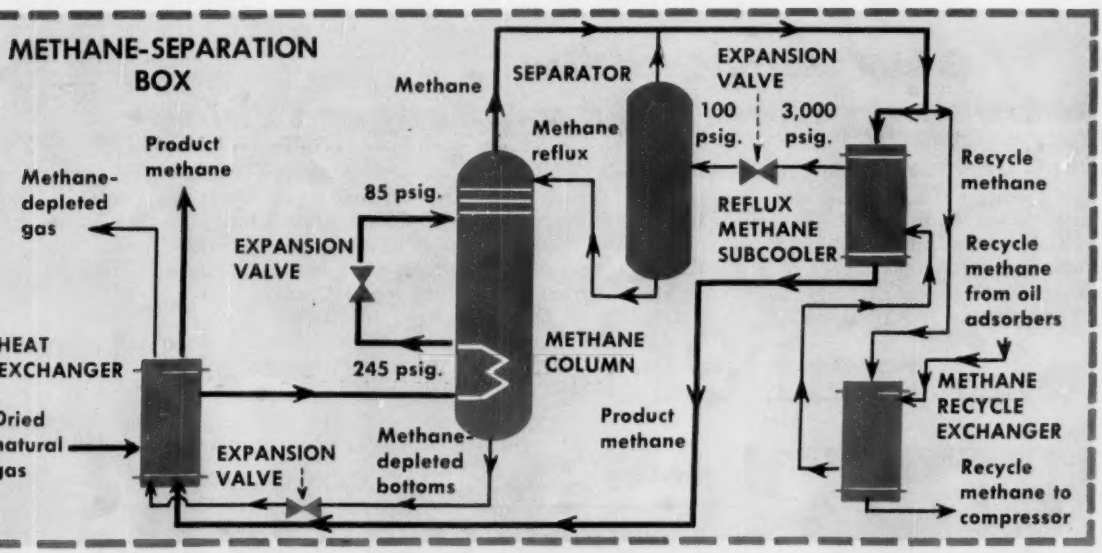
▶ **The Bottoms**—Meanwhile, the depleted portion of the feed gas has gathered as liquid in the bottom of the methane separation column. From the column, it passes through an expansion valve to the exchanger that cools entering feed; then it leaves the box.

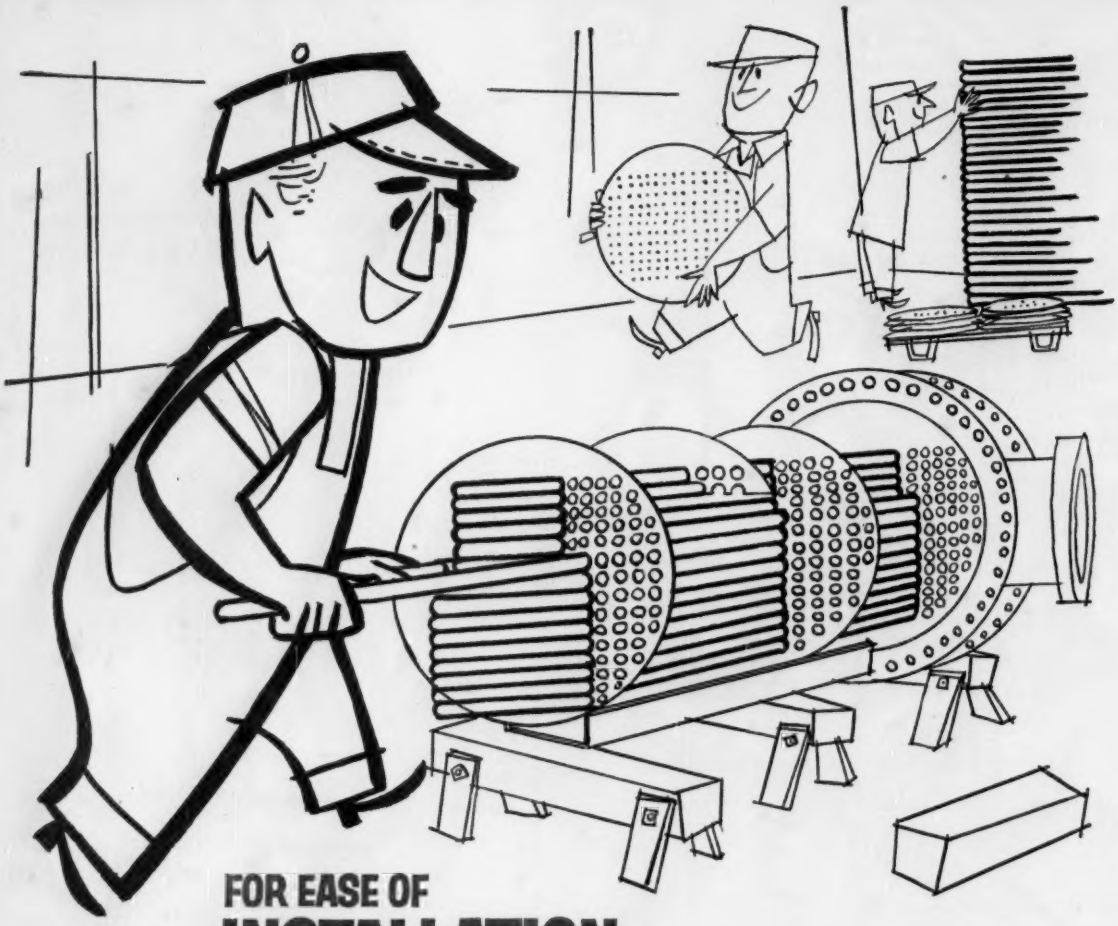
Once outside the box, the depleted stream may be compressed and piped away, or may first be used for alumina reactivation if one of the dryers is spent.

Dryer reactivation is a two-step operation. First, the gas stream is heated and then passed through the dryer to remove water. After water removal is completed, additional gas is first cooled, then sent through the dryer to return the desiccant to its normal operating temperature. In both cases the gas exiting from the dryer is cooled, compressed, then piped away from the methane unit.

▶ **Once a Year**—When the plant requires defrosting, it will first be purged with nitrogen, then defrosted with warm air. After defrosting, the unit will again be purged with nitrogen before it starts up.


Methane-depleted gas
DEPLETED-GAS COMPRESSOR
PRODUCT HEATER
Steam
Methane (99.99+%)
Product methane
DRYER REACTIVATION BLOWER
Recycle methane from oil adsorbers
OIL ADSORBERS (2 stages)
Gas for dryer reactivation
METHANE-SEPARATION BOX
(See below)
Recycle methane to compressor
Methane-depleted gas
DRYER FILTER
Dried natural gas
METHANE COMPRESSOR
Dust


METHANE-SEPARATION BOX
Methane
SEPARATOR
EXPANSION VALVE
100 psig.
3,000 psig.
Methane reflux
Product methane
Recycle methane
Methane-depleted gas
85 psig.
REFLUX METHANE SUBCOOLER
EXPANSION VALVE
Recycle methane from oil adsorbers
METHANE COLUMN
245 psig.
METHANE RECYCLE EXCHANGER
Product methane
Methane-depleted bottoms
EXPANSION VALVE
Recycle methane to compressor



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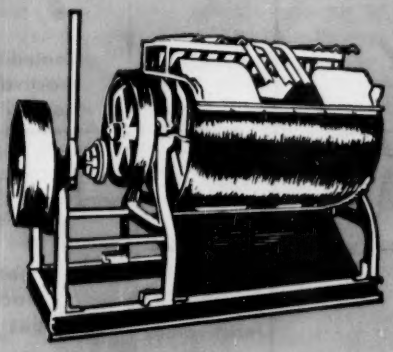

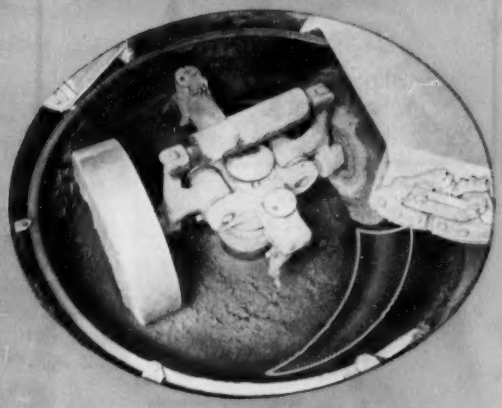

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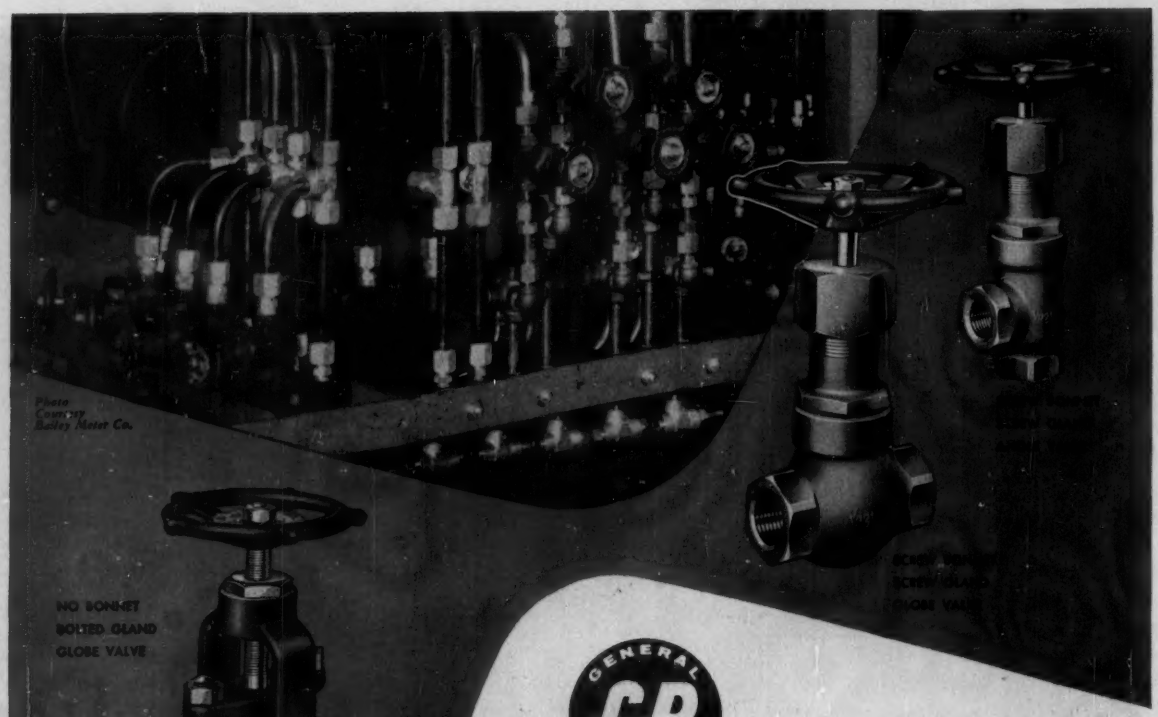

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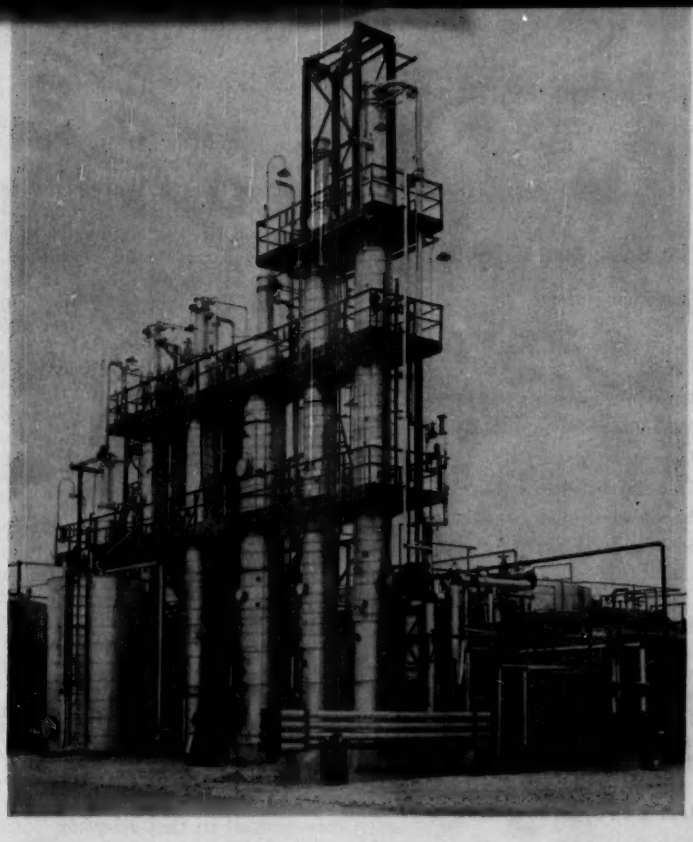

SUCCESSFUL startups of plants like this require many months of detailed planning and much sustained hard work on the part of everyone concerned.

How to Prepare for Plant Startups In the Chemical Industries

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New products or processes as well as expansions in existing process units that are announced with increasing regularity indicate the rapid growth in the chemical industry today. Sooner or later, each of these growth projects involves a period of initial plant startup. In this report, we will discuss the many interrelated activities involved in plant startups, particularly as they apply to the chemical process industries.

Regardless of how large or small the project, the job of getting on stream is most important; until production reaches design rate, there will be no profitable return on money invested in the particular venture.

Therefore, once you have appropriated capital for new plant construction or modification you must establish integrated schedules for the engineering, construction and initial operation. To obtain the most effective use of time, materials and personnel, close coordination of the many activities preceding or in support of startup will be essential. Money dedicated to construction and startup must be carefully budgeted because delays in construction or in getting the plant to reasonable capacity can rapidly devour money set aside for the nonproductive startup. There will be many intermediate goals to meet as the project progresses, but all efforts are ultimately directed to achieving or bettering the plant startup date, which may be coincidental with over-all completion of construction but often precedes it. This is particularly true where process areas or pieces of equipment can be installed in phases, allowing a corresponding program of startup by stages.

Generally, management assigns responsibility for coordination and administration to a "Project Manager" or "Project Engineer". Procedures and techniques followed by the "Project Engineer" during the design and construction phases have been extensively described in the literature, but the plant startup period has received only nominal treatment.[1-5, 8, 10, 11] So in this report, we will elaborate on how over-all efforts of process development, engineering, construction and production personnel must coordinate to accomplish successful and on-time plant startups.

We include considerable detail on techniques for facilitating startup from the operating point of view.

We have organized subject material according to the following outline, which we will develop as the report proceeds:

1. Organizing for startup
2. Preparation of schedules
3. Recruiting and training
4. Operating manuals
5. Pre-startup activities
6. Major phases of initial operation

Naturally, as the magnitude or nature of a project varies, so will the extent to which effort must be applied under these various categories.

Relationships that may exist between customer companies and their architect-engineers or contractors will also govern the particular approach to a startup program.

In organizing for startup, therefore, one should clearly understand the type of project involved, the area of responsibility indicated and plan accordingly. Fig. 1 outlines several typical alternate situations which may prevail in a new plant startup program.

Despite infinite variety in plant size, complexity and processes or products, certain basic steps are involved in all startup programs. These usually include the phases summarized in Table I, though the sequence may vary to meet individual requirements. Some phases may be handled simultaneously; some may require little or no attention. The nature of the job will usually dictate how the programs are put into action and administered.

Let us consider the first step: Organizing for Plant Startup.

The very first move is up to management—it should delegate to some individual the responsibility for over-all coordination of the job. This person, who might actually be the Project Engineer or Manager, would then guide the project through design, construction and finally plant startup. Alternatively, he might be an assistant to this project manager, concentrating his energies only on the many phases of Table I.

In any event, once management has decided to proceed with new or expanded facilities and the basic approach has been defined at top level, the project manager or his designee must see that the detailed program is carried forward expeditiously. The necessary staff for handling startup functions of Table I should then be assembled.

The Basic Steps—Table I

- Organizing—general planning and scheduling
- Personnel recruiting and development of organization
- Review of engineering design
- Preparation of operating manuals
- Training programs
- Construction follow-up
- Pre-startup activities
- Initial operations

Select A Project Engineer

Articles by Morton[1], Browne and Brewer[2], Gordon[3], and Rase and Borrow's book[4] on project engineering describe the selection and duties of the project engineer. Gordon and Browne and Brewer emphasize that such individuals should be picked, if at all possible, very early in the program. Background gained in preliminary economic studies, negotiations with engineering firms, and contact with research and development groups regarding the job will be invaluable in later direction of the project. This is certainly a desirable objective but very often unattainable.

Frequently, top executives will get the ball rolling on a plant venture themselves, then assign one or more staff engineers to follow through. But it is essential that management choose the key project manager to coordinate the total program by the time process design and engineering are underway.

What type of individual is chosen for assignment as project manager or startup coordinator?

Size of the project or company-contractor arrangements, if any, may prevail in this selection.

For large, integrated facilities, the future plant manager is very often selected as the project engi-

Some Typical Routes to Successful Chemical Plant Startup

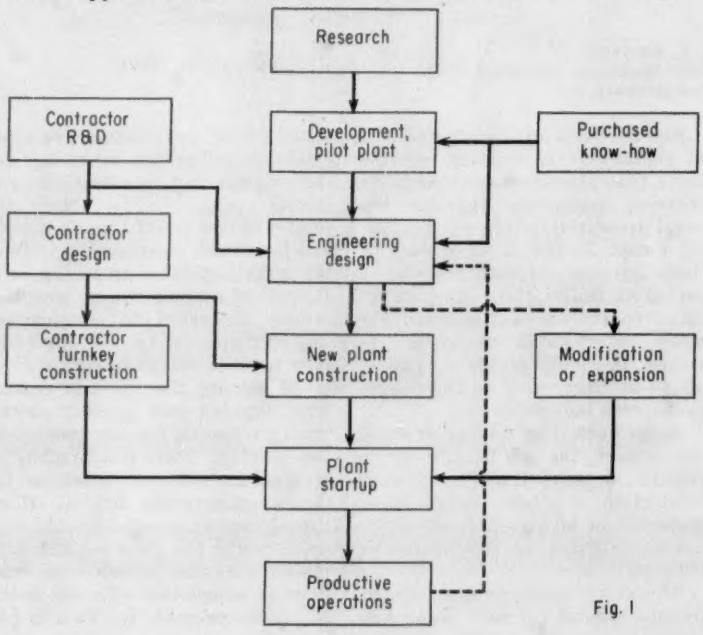


Fig. 1

neer. Administratively, he may report to a top executive such as a Divisional Vice President or equivalent. In smaller jobs, the project man might be a senior process engineer who has been associated with the earlier development of the process, or one who has had suitable design, development and production experience. His efforts could be directed by a local plant manager, a chief engineer, or by a "new facilities development" with corporate-wide responsibilities. The important thing is that one person with adequate experience and ability must be selected to direct the job.

When consultants or engineering contractors are involved in a new plant program, they may have to provide the project manager. Preferably both the company and the engineering firm will appoint key project men. In such cases, design and construction is often guided primarily by the engineering firm while the client's engineer directs the operational phases. See articles by Eames[3] and Gordon[4] for an amplification of these relationships. As Browne and Brewer[2] point out, mutual responsibilities of the contractor and the plant owner can not be overemphasized during the critical startup period.

Table II shows examples of some typical new plant startups and the project leadership involved.

Consider the Plant Involved

In Table II, note the time for getting units on stream—a week to six months. Obviously, the type, size and complexity of the plant has a bearing on the time. A conventional or duplicate unit (turnkey) should go on line reasonably smoothly on schedule. On the other hand, novel or difficult operations being started up for the first time on commercial scale may require extended periods as process or equipment problems are encountered and solved. These problems will vary in frequency and significance as a function of (1) extent of research or piloting; (2) complexity of chemistry or equipment and (3) special properties or hazards associated with the process.

A project involving pyrophoric and toxic boron hydrides with which I was associated recently is a good example of factor (3). Need for extra precautions in operations and for complicated purging procedures preceding maintenance increased the time required for an orderly and safe startup.

A project of this type justifies significantly more effort in organizing and planning for plant startup.

Real Situations Show Wide Variety of Possible Approaches to Plant Startup—Table II

Plant Type and Size	Comments	Project Manager/ Report to	Assisting Supv. Staff
1. Sulfur recovery 40T./D.	Turnkey job. Simple operating manual; one week of training; research men (pilot experience) started plant with operators aiding and learning. On stream in one week.	Contractor's Engineer/ Plant Manager	2—Production supervisors 2—Research engineers
2. Insecticide 5T./D.	Pilot group that developed process specified equipment, wrote operating procedures & assisted in plant startup. Engineering firm designed; plant did construction. On stream 8 wk. from start of design.	Pilot Plant Section Chief/Production Supv.	4—Shift foremen 3—Engineers
3. Organic solvent 3T./D.	Process defined to plant engineering by research group. Constructed by plant. Revision of existing equipment. On line in 1 mo.	Resident Project Engineer/ Corp. Development Manager	Production supervisor 4—Shift chem. eng. 4—Foremen
4. Inorganic 6T./D.	Fully piloted and specified by Process Eng. Dept. Company designed and constructed. Startup in 3 mo.	General Manager/Vice-President of Operations	Production manager 4—Shift foremen (from pilot plant) 3—Process engineers
5. Petrochemical 100T./D.	Contractor designed and built. Turnkey plant. On stream in 3 process steps over 5–6 period.	Plant Manager/Vice-President of Operations	Full staffing of large new plant required outside recruiting, supplemented by process engineers with pertinent production & development background.
6. Inorganic specialty 1T./D.	Company process specified. Contractor design; company subcontracted construction. On stream in 4 months. New technology, special handling.	Production Manager/ Director of Operations	Outside recruiting for operators, foremen & few others; all lines of key personnel came from within company.
7. Organic specialty 2T./D	Semiworks process unit to produce material for initial sales; modified existing plant equipment; plant installed. Startup in 2 wk.	Production Engineer/ Plant Manager	Pilot-plant section chief; Senior chemist 3—Shift foremen
8. Organic interm. 2T./D.	Fully piloted; company designed and engineered; subcontractor built; existing Production Dept. started. On line 3 mo. as process problems were solved.	Resident Project Engineer/ Corp. Development Manager	Operating sup't. 4—Shift engineers & foremen

Startups No Picnic

In units involving newly developed chemical processes, technology and equipment may not be fully proven and you can anticipate more frequent startup difficulties. Staffing must be planned accordingly and operator training is usually more extensive. Certainly, a higher ratio of technical to nontechnical personnel should be on hand in contrast to the turnkey job.

For that matter, any plant startup can entail an element of the unknown. Equipment may not work as designed for a number of reasons. Construction may not erect the plant exactly as specified, despite inspection in the field. Plugging or leakage will occur in equipment where least expected. Until one exercises the newly installed units and determines their particular characteristics and eliminates the bugs, operation will be anything but routine. For this reason, startups can be exasperating, exhaustive, and demanding of the utmost in patience, energy and ingenuity.

Not For Pessimists

Any startup organization, be it small or extremely complicated, should be characterized by an aggressive and positive attitude. It is easy for people to point out reasons why something will not work before it is actually tried. Part of the planning by a startup organization is to line up alternate solutions to potential problems. Sometimes, common sense and a driving effort to make a system or unit perform will result in success in the face of engineering calculations or "scientific logic" suggesting the contrary.

Plants for new chemicals or those involving now processes are most vulnerable to startup uncertainties. In spite of guidance from pilot plant or laboratory information, many factors are never checked adequately prior to plant operation. As a matter of fact, pilot experience may sometimes be misleading or erroneous.

For various reasons, a unit may perform better than designed. But, unfortunately, the same factors may lead to less than anticipated results on many occasions. Since this may occur more often than not, it is essential that the startup crew make every effort to force a unit to work as designed, somehow or other. Then, once on line, they can develop improvements in equipment, output and product quality.

In one process with which I am familiar, data indicated that plant scale equipment would be marginal concerning agitation as it influenced reaction rate.

But in actual practice, results were even better than in small scale equipment. Equipment configuration, catalytic effects or other variables came into play and gave better than expected results.

Even in the scale-up or expansion of commercial processes, unknowns will develop. It appears that all plants, and even those built from identical blueprints, have their peculiar characteristics and difficulties.

Still another factor that affects basic organizing for plant startup is the relationship between the company and outside contractors or engineers who may be involved in the venture. The degree to which an outside consultant or contractor may be responsible for design, construction and initial operation of a new plant naturally influences different functions for which the company and outside representatives are responsible. Some engineering contractors handle the design and construction entirely, then turn the plant over to the client for startup. In other cases, they may assist in startup, providing operating manuals, key operators and engineers. After demonstrating that performance meets guaranteed design, they then turn the plant over to the operating company.

Large corporations generally handle the complete project entirely from within. However, individual staff and line departments may still follow the same startup planning as that applied when consulting engineers are working jointly with the company.

Proceed With Startup Planning

Once the project engineer has been given responsibility for the job, he should proceed with prosecution of the basic steps of Table I. Together with management, he will set his basic goals, keeping in mind the factors we have just discussed. He will line up key people and establish a schedule for interrelated activities.

If the project manager has overall control of design, production and startup, he will see that the necessary research and development data (basis for design) have been collected and transmitted to the design department for preparation of specifications, process flowsheets and, finally, construction drawings. He will coordinate with the construction department those activities relating to the conversion of this design into a finished facility. This will cover specifying and purchasing of equipment, expediting delivery, cost accounting, actual installation, etc. His ultimate function is to develop the operating organization capable of handling all the necessary startup functions.

If our situation involved a project engineer who was restricted to the startup phase alone, he would still work closely with those directing the earlier phases, to achieve a smooth and efficient transition from construction to operational status.

Maintain R&D Liaison

Even as startup programs get under way, the project manager must continue liaison with Research and Development. Refinements in process data, corrosion information, control methods and similar background, which may not have been available or adequate during initial design, will continue to evolve from the development groups. This must be applied where possible to improve the startup picture.

Where a new unit is being installed in a going plant, the project manager must work very closely with the resident plant manager to coordinate on necessary support services. Having agreed upon basic policies, these two key people will see that all departments and personnel called upon for assistance will provide full cooperation.

At times, the project manager may relinquish his authority to others when they are better qualified to carry the ball. An example is the construction phase where an assistant project manager or construction superintendent could take full responsibility for installation of the new facility. Similarly, a senior engineer might supervise the design phases. Both these people would follow the objectives set by the project manager.

Delegating to others the authority to pursue portions of the job is a necessary approach the project

manager must take. He may be preoccupied with other phases of the job that must proceed concurrently. But it is essential that clear-cut lines of communication and definition of authority be maintained. Across-channel contact is desirable to cut red tape, but major decisions and policy matters must be properly channeled so that the responsible head of the job, the project manager, retains proper control of the situation.

Wanted: Operating Experience

Someone with operating experience should participate early in the design phase. Such a man could very well be the project manager himself. Or, he could be a production or operating engineer of the type described by Huffman.[6] Many of the decisions made during the design period must reflect the experience, know-how or intuitive judgment of the operating man. Such decisions, applied at little cost or effort early in the game, may represent difficult and costly modifications after the design is fixed or the plant actually built. The operating engineer should define best arrangements for operation, maintenance and safety. He must consider not only normal operating situations, but others, such as startup, shutdown and the possibility of future expansion. Many a production man has found, too late, that his plant or equipment is designed to operate but not to shutdown or be repaired.

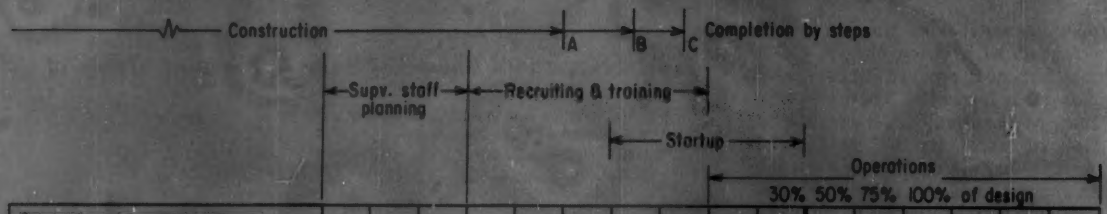
Scope of the job defines the size of staff and the interrelationship with existing staff or department groups. Personnel who have been in the R&D, design and construction steps are potential candidates for a startup organization. In small projects, relatively few people will be needed; in large jobs, complete staffing of all functions will be necessary. Men may be drawn from various areas of the company and from the outside as well. Articles by Lyon[7] and Dunwoody[8] discuss in great detail the approach to personnel recruiting for new chemical plants.

In the early phases, only a few key people may be required to follow through with the project manager on design and engineering. As construction gets underway, more men will be added to follow progress in the field, to train first-

Project Manager's Check List Helps in Planning—Table III

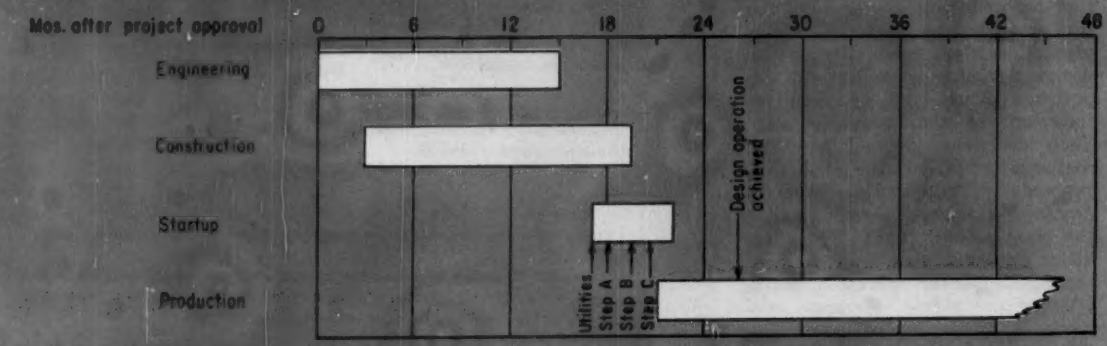
1. General planning and scheduling on basis of scope set by management.
   - Definition of staff and hourly jobs.
   - Labor relations aspects.
   - Selecting key people.
2. Recruiting organization.
   - Indoctrination of supervisors.
   - Loan of personnel from R&D, engineering, staff group, consultants.
   - Recruiting of hourly operators, mechanics, etc.
3. Training of personnel.
   - Supervision and hourly (operators, mechanics).
   - Indoctrination, field trips, pilot-plant or other plant assignments.
4. Preparation of operating manuals.
   - Review of basis for design, R&D reports on properties, process, techniques.
   - Process flow sheets, raw-materials specifications, process materials and product specifications.
   - Standard operating procedures.
   - Emergency instructions.
   - Revision or reissue of old existing manuals.
   - Safety manual, quality control manual, log sheets, check lists, inventory records.
   - Equipment specification book.
5. Engineering design, procurement and construction.
   - Process flow sheets, equipment design, layout and specifications.
   - Purchasing, expediting equipment.
   - Construction-installation, inspection.
6. Pre-startup activities.
   - a. Review of engineering design for operational features. Foundation for ultimate startup.
   - b. Construction followup—field inspection by operation and maintenance supervisors. Supply of "punch lists." Review of progress charts with relation to startup scheduling. Review of initial pressure-testing or mechanical check. Defining priority on completion. Take over from construction (beneficial occupancy).
   - c. Spare parts selection. Lubrication specifications and schedules.
   - d. Raw materials and supplies (max.-min. stores). Amounts required, lbs./batch/hr., molar basis. Ordering through purchasing. Storage considerations.
   - e. Accounting—chart of accounts. Proration of services to operating departments.
   - f. Sales—shipping arrangements.
   - g. Miscellaneous. Waste disposal, air pollution. Services from parent plant if applicable (utilities, maintenance, laboratory, accounting, purchasing, personnel, etc.)
7. Startup activities—when physical plant is complete.
   - a. Mechanical and instrument check-out. Jointly with construction. Utilities activated.
   - b. Final acceptance procedure.
   - c. Pressure-testing programs. Rupture disks, safety valves, flame arresters, equipment in general.
   - d. Flushing, purging, visual inspection.
   - e. Calibration of tanks, flows, etc.
   - f. Simulated operation, dry runs.
   - g. Final safety inspection.
   - h. Initial operation—final planning sessions to define responsibility, emergency procedures. Tools and materials for job on hand.
   - i. Quality control, analytical program.
   - j. Design performance checks.
   - k. Production scheduling.
8. Operational hints. A primer for production engineers and foremen.

Progressive Estimates Help Keep Running Record of Progress and Delays—Fig. 2

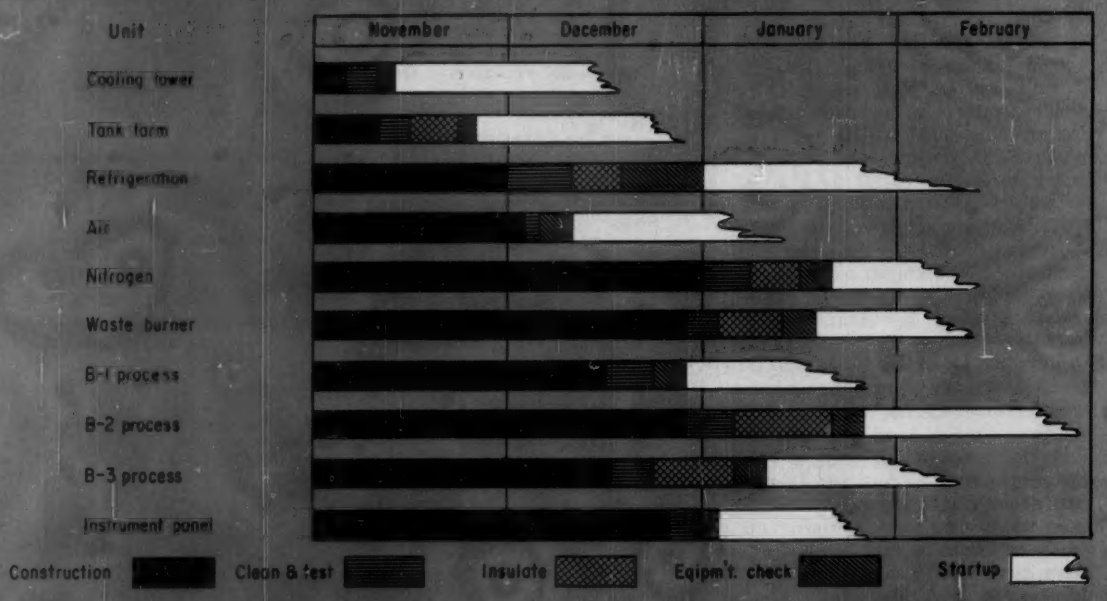


Original construction estimate 15 mo. before startup	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
First revision 11mo. before startup	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Second estimate 6mo. before startup	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
Actual startup	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.

How Various Activities Dovetail in New Plant Construction—Fig. 3



Detailed Schedule Helps Supervisors Follow Progress by Units—Fig. 4



line supervision, and to complete other preparatory work.

Key superintendents and senior engineers are usually enlisted 6-12 months before startup, to follow design and construction work. Those not required to follow construction would be lined up 4-6 months before startup. Foremen are selected about 3 months before startup, with operators recruited for training about 6-8 weeks prior to startup. Operator training time could be reduced to possibly four weeks for simpler installations or if a core of more experienced operators were available for transfer to the new job. But when inexperienced men must be trained for a complicated operation, 3 months is not too long a time to indoctrinate a new crew in the mysteries of plant operation.

Once a project manager has his basic program defined, with key personnel available and organization of the project well underway, major strides can be taken. Activities involved in preparing for startup can be amplified greatly beyond the items of Table I. Table III on p. 111 shows a more detailed project manager's check list of essential jobs. Eames[5] has published a similar list, dealing with more of the mechanical phases preceding startup.

Preparation of Schedules

Schedules of various types have been employed in planning the extensive activities of a startup program. The more complicated the plant involved, the more essential and detailed the schedule becomes. Fig. 2, 3 and 4 and Table IV are examples of schedules which I have used. In each case, the startup schedule is of necessity based upon schedules relating to the plant construction program.

Project managers must realize that the startup schedule may have to be modified as dictated by construction progress. Inadequate labor, late equipment deliveries and inclement weather are typical causes of extensions in construction schedules. As plant completion dates are delayed, so must startup activities be appropriately modified.

It is good practice on big projects to bring the startup schedules up-to-date on a bimonthly basis early in the plant construction period.

As the job approaches about 75% completion, the situation should be checked biweekly and even weekly to coordinate most effectively with recruiting and training steps. If construction programs drag out, startup budgets will be overrun unless delays are appropriately compensated for in the startup schedule. Even with tight planning, project managers are more likely to have the startup organization ready ahead of time, rather than too late.

Excessive consumption of startup funds by an extended startup necessitates extra effort to get plants on stream and up to capacity in less time than originally planned. If the project manager's personal initiative does not produce such effort, he can expect to receive directives from management, sales, etc., insisting that all lost time be made up by the startup crew.

Fig. 2 shows the major phases that were involved in a plant composed of three primary process steps. We plotted general startup functions against time and contrasted them with the controlling construction completion schedule. As each of the process steps was completed, operations checked it out and proceeded with startup.

One month was allowed after all units had been physically completed to achieve integrated operation of the three major steps. In the succeeding month, production output was established at 30% of design. Design capacity was planned for three months thereafter. Three estimates made during the course of the project indicate delays in the overall program due to extensions in the construction timetable. The actual schedule ultimately achieved is given for comparison.

Fig. 3 gives the basic relationship between engineering, construction, startup and final production programs for this plant.

Supplementing the schedule of Fig. 2 is another which provides for more detailed programming of startup itself. This is given as Fig. 4. It is advantageously employed by the production supervisor in charge of operational startup. Here, the process area is divided into sections or packages, each of which can be separately checked out and put on the line. You can see that close coordination between construction and operating groups is essential during the transitional period.

Table IV shows a different form of startup schedule, this for a more complicated plant involving several discreet process and/or support areas. Dates for hiring of operators, completion of equipment check-out and anticipated on-stream integration with other areas are tabulated on the basis of predicted construction completion times. Appropriate revisions of this schedule are made periodically as construction is completed or delayed and

Schedule Shows Personnel and Hiring Dates—Table IV

Plant Section	Description	Estimated Date Construction Complete	Hire Hourly Date	No.	Complete Unit Checkout	On-stream Integration
1.	Utilities					
	Water	10/15	10/1	(8)	10/20	10/25
	Steam	10/30	10/1	(4)	11/10	11/15
2.	Halogenation					
	1st reactor	3/15	3/1	(8)		
	2nd reactor	4/15	3/15	(8)		
	Balance	3/1			5/10	5/20
3.	Reduction	3/31	2/24	(8)		
			3/9	(8)	3/30	4/15
4.	Purification	3/22	3/1	(8)		
			3/15	(8)	4/15	4/20
5.	Pyrolysis	4/25	3/23	(8)	5/1	5/8
			4/1	(20)		
6.	Hydrogen	2/1	2/24	(8)	3/20	4/10
7.	Tank Farm	2/1	3/1	(4)	2/15	5/30
8.	Waste Disposal	3/15	2/24	(4)	3/31	4/15

as individual units are taken over for startup.

Watch the Budget

The project manager must find ways to decrease his own startup program, if he is to hold startup costs within budgets in the face of construction delays. Operating representatives in the field during construction can help in inspection, revision, expediting and scheduling activities. By indicating where work emphasis should be placed, take-over of units can be scheduled so that startup will be shorter or more efficient.

On the other hand, there is a construction viewpoint to be considered—most economical installation schedules may not be consistent with needs of the operating group. Compromise is essential for the best balance of economy in construction and operation.

Personnel Recruiting, Training

Following the general planning aspects of startup, the next responsibility of the project engineer is personnel recruiting and training. He will require people for service work, maintenance and operations —the three basic functions in any plant. Key staff and line positions in these categories in the new plant organization should be filled by capable people.

In a large project, the project manager may be scheduled as the future plant manager or superintendent. If someone else is given this job, the new man soon accepts full responsibility for operations from the project manager.

In like manner, the project engineer in cooperation with the key production man (or plant manager) lines up other top supervisors such as the maintenance and engineering manager, an administrative services manager, the chief chemist, etc. These principal supervisors work, in turn, with Personnel on further recruiting of the next levels of plant staff as dictated by scheduled needs. Specific positions, salary ranges, job descriptions and required hire dates will be supplied to the personnel department along with necessary approved requisitions covering each person.

Depending upon the magnitude of the project, there may be no need to go outside; or a considerable number of people may have to be hired as new employees.

Where services of Accounting, Purchasing, Personnel, and so on can be provided by an existing overhead staff, the project manager may require only an administrative man or small group to serve in a liaison capacity. Clerks or specialists may still be necessary on the spot to supply necessary data or to expedite. In large plants, independent service staffs are normally set up to handle the job—home office simply establishes policies and procedures for these local groups.

There have been numerous articles written on personnel selection. Development of the organization for startup has also been discussed at length. Articles by Lyon[7] and Dunwoody[8] are typical and we recommend them to the reader who desires more background on the subject.

Before leaving this point, I would emphasize that among the factors to keep in mind when recruiting a plant staff for startup is that a man with one year of plant startup experience may be equal to another who has had two or three years of routine experience in an operating plant.

Operator Recruiting

Recruiting of hourly personnel is dictated by the startup schedule. The number of operators and mechanics needed depends upon size and nature of the process or plant. It is good practice to plan on fewer men than anticipated and add more later if really needed.

Before hourly men are recruited, there must be a clear-cut outline of conditions of employment. If a union contract is not in effect for reference, equivalent rules, policies and procedures should be agreed upon by plant management so that such information can be supplied during the recruiting period. Wage rates, lines of progression, type of work, job classifications, seniority provisions and similar items should be described to prospective employees.

In a new plant startup, where extended training time is anticipated, special conditions may have to be defined for new employees. Since precise time of plant completion and startup cannot always be specified, normal progression periods may be extended. Opportunity to learn the job in all its aspects may not be provided in the same time that is possible in a going plant. Men may remain at training rates of pay longer than normal.

On the other hand, as various positions are filled, key jobs at higher wages, such as head operators, will be attained by the best trainees. Such promotions will be more rapid than in normal progression in an established plant. Management's right to assign best qualified men as required is essential for startup. But, eventually, seniority as a basis for job preference usually applies to promotions.

Selection of prospective employees will be based upon several criteria. These include (1) educational background, (2) job experience, (3) physical condition, (4) general intelligence (rating in SRA basic intelligence test, Wonderlic personnel test or equivalent), (5) results of standard mechanical aptitude or comprehension tests (for maintenance work,) (6) general attitude shown in personal interview, and (7) personal and business reference checks. Careful screening and selection will result in less attrition for poor performance.

Table V shows a typical roster list proposed for a new plant installation. Note that surplus men employed for startup are reduced after the unit is lined out. Transfer back to previous assignments (engineers) and transfer, attrition or lay-off of hourly people takes care of the surplus.

Training Program

Two phases of personnel training are usually involved in the startup of a new facility. First, supervisors and engineers who will be responsible for the operation and maintenance of the plant or unit must assimilate the basic data relating to plant design and operation.

Second, operators and other hourly workers must be given suitable training to prepare them for their assigned duties. Since training programs and methods have been covered extensively in the literature, we will discuss the subject only briefly.

Supervisory training can be done in a variety of ways. Formal classes or informal sessions while following progress of construction have both been used. I prefer the in-

formal program, which can start after shift foremen, engineers and other key personnel are assigned to the project. People who have worked with the project manager on the design and construction phases can lead discussions and give instructions. In addition, representatives from Research and Development can be called in to lecture on chemical and process background. Classes or group meetings are scheduled during the day and frequently in the evenings so as not to interfere with other day work associated with plant construction.

Much of the training will be based upon review of process and engineering flowsheets, chemistry of the process, design of the plant, functions and inter-relationships of various pieces of equipment and operating procedures. Such information should be supplemented, however, with background on the company, standard company procedures, labor policies and training techniques. This will be essential preparation for the job of instructing hourly operators and mechanics.

Foremen and engineers can prepare sketches, charts and simplified flowsheets, during training sessions, for subsequent use in the hourly training course. Maintenance foremen should include in their schedule a concentrated review of equipment specification sheets and vendors' literature relating to design and servicing of mechanical units.

One important point which should be emphasized during the supervisor training sessions is the employee's responsibility to properly administer corporate policies. Establishing and maintaining good human relations and high morale in the plant group must likewise be stressed. Supervision must lead the startup crew and sustain a driving effort in getting the plant on line in spite of various handicaps and problems.

Operator Training Program

In hourly training programs, all personnel are usually grouped together for orientation lectures concerning the company, plant, policies, procedures and similar general information. The Safety Department provides instruction on toxicity, fire and explosion hazards, protective equipment, first aid and safe practices. Thereafter, separate special-

An Estimated Roster for a New Polymer Plant—Table V

	Startup		Ultimate Operation	
	Per Shift	Total	Per Shift	Total
Technical				
Project Mgr. (Supt.)		1		1
Ass't. P/M (Ass't. Supt.)		1		1
Process Eng.		3		1
Shift Supvs. (Technical)		4		4
Operations				
Shift Foremen	1	4	1	4
Operator				
1st Class	1	4	1	4
2nd Class	2	8	2	8
Reduction Operator				
1st Class	1	4	1	4
3d Class	2	8	1	4
Purification Operator				
1st Class	1	4	1	4
2nd Class	1	4	1	4
Packout	1	4		1
Quality Control				
Shift Chem.	1	4	1	4
Maintenance				
Foremen		1		1
Fitters		3		3
Millwrights		3		2
Shift Mechanics	2	8	1	4
Instrument		1		*
Total	13	69	10	54

* Available from Central Maintenance

Classroom Work Is Essential to Proper Personnel Training

Training Outline—Table VI

A. Review of company.
   - Orientation.
   - Clarification of questions.

B. Review of fundamentals.
   1. Properties of matter.
   2. Chemistry—relation to process.
   3. Unit operations involved.
   4. Mechanical fundamentals.
   5. Electrical background.

C. Practical matters.
   1. Plant equipment—how it is built and operated.
   2. Instrumentation and its application.
   3. Operating techniques.
   4. Safety and fire protection.

D. Process flow sheets.
   1. Classroom review.
   2. Field checking of lines and equipment. Tracing of piping.

E. Mock operation.
   1. Classroom consideration.
   2. Simulated operation in field.
   3. Practice of startup, shutdown.
   4. Sampling and controls.

F. Maintenance work.
   1. Following and checking construction.
   2. Review of typical maintenance jobs.

ized sessions are held for those going into operations, maintenance or instrumentation.

Foremen, superintendents or engineers are the logical instructors for operating personnel and the operating manual is a basic reference book on the plant or process. Supplementing this manual may be a general training book covering subjects such as those listed in Table VI. Weber[2] gives a corresponding outline for a larger refinery startup training course.

Keep records of training performance to aid in the selection or rejection of men. Give oral and written examinations as training proceeds. In particular, check performance in the field during mock operation to determine how much a new operator knows and understands and how he reacts instinctively under emergency situations.

After the basic phases of the training course are completed (Items A, B and C of Table VI) operators should be assigned to specific areas or units for advanced work. Training, thereafter, should concentrate on preparing the man to handle a definite job. Best qualified men are assigned to the more important positions such as control-panel or chief operator.

Emphasize Practical Phases

Experience with several training programs has indicated that primary emphasis should be put on the practical phases (Sections C and E of Table VI especially). Average operators are not likely, as a rule, to assimilate the fundamentals in the relatively brief span of a pre-startup training course. Extended courses given after the plant is on line will eventually be more beneficial.

Place major emphasis upon teaching operators the step-by-step procedures involved in operating equipment and running an integrated process. Demonstration in the field by engineers and foremen and then performance by the new operators under close supervision on simulated, then actual, operations seems to be the best approach.

Following the general orientation course, maintenance mechanics next proceed to special training that will take into consideration the skill level of new employees and the skill requirements for plant maintenance. We assume that a nucleus of well-trained and well-qualified mechanics in the various major crafts will be on hand after the recruiting program has been completed. The remainder of the crew will have limited backgrounds but will have been selected because of their potential for mechanical-type jobs.

Give Background Information

The first phase of training should constitute what may be called "Appreciation Courses." Each mechanic, regardless of trade or skill level, should be given information relating to general features of the operating areas, utilities systems and various types of plant equipment such as pumps, compressors and exchangers. Give such background in daily lectures. Each man will thus become familiar with the duties and responsibilities of others with whom he will be working in the future.

The second phase of training for mechanics, the one receiving major effort, covers specific duties and skills. Courses relating to millwrighting, pipe fitting, welding, electrical and similar crafts are conducted by foremen, supervisors or engineers, assisted by the first-class men who are on the roster. Such training is carried on concurrently with the appreciation lectures. Alternating the two types of training on a daily basis helps sustain employee interest during the training program.

General maintenance mechanics qualified for work in several skills have been used in many plants. Training should provide such men with a reasonable amount of instruction in fields other than that of their primary skill.

Prepare Operating Manuals

One of the most important and certainly indispensable aids to plant startup is the Operating Manual. This document, in some form or another, contains the summation of general knowledge on the new process. It describes the proposed method of operating the plant—the Standard Operating Procedure (SOP). As such, it usually serves as the basic training manual and a reference work on the project.

Supporting documents such as The Basis for Design, Equipment Specifications, and Analytical Methods for Quality Control are often included with the manual. As stated by Browne and Brewer[3], it truly represents the new plant "Bible".

Successful startup operations require that the personnel involved have a good understanding of (1) process design, (2) variables affecting yields, quality and continuity of operation, (3) performance characteristics of major equipment, and (4) provision for protection of personnel and equipment in case of emergency. Such information should be in the Operating Manual.

Standard Operating Procedure (SOP) section is basically a guide to startup and may not necessarily define the optimum way of running the equipment. The initial writeup gives a standard approach that must be followed by different shifts to achieve continuity. As operation proceeds and experience is gained, SOP's will be altered. Safety, economy, sustained production and quality must be considered in arriving at the final procedure.

Table VII summarizes a comprehensive outline describing contents of the Operating Manual. We emphasize that the detail required for a large project can be reduced significantly when a smaller job is involved.

SOP Must Be Flexible

The author of an SOP must write in a manner which provides for sufficient flexibility in coping with new or unexpected situations. Experienced operating supervisors can then make on-the-spot decisions in the interpretation of the SOP without deviating from the basic intent of the instruction. Text should be clear and concise—there is no place for ambiguity. Use the imperative mood.

Information on process equipment or mechanical features of the plant are often consolidated in a separate supplementary volume to the Operating Manual. This may be titled "Mechanical Catalogue," "Manual of Plant Equipment," or "Equipment Specifications."

In any event, this section would cover design and operating specification sheets and sketches of pumps, heat exchangers, compressors, reactors, columns and other process equipment. Manufacturers' special instructions for assembly, repair and servicing of the equipment could also be included. Spare parts lists are covered in some instances, though these are often assembled independently by the Maintenance or Engineering group.

Though not convenient for inclusion in an operating or equipment manual, detailed engineering drawings may be edited, reduced to 8½ × 11 in., or other suitable size, and bound into the Specification section of the manual for ready reference.

Include Basic Data

Supplementary to the Operating and Equipment sections of the manual may be a special "Basis for Design" report, summarizing significant laboratory or pilot-plant operating data, miscellaneous information on properties of materials handled, background data from the literature, the original proposals for plant layout, equipment selection, operating procedures, safety considerations and other data of value to the design and production people. It is from this first report that the final operating manual ordinarily evolves.

Copies of operating manuals should be available for reference and training purposes well before recruiting of hourly personnel starts.

Operating Manual Requires Detailed Outline—Table VII

A. Table of contents.
B. Introduction—scope, history, general background.
C. Description of process.
   - Simplified—general.
   - Chemistry of process—material properties, material specifications, analytical methods.
   - Process steps in detail—effect of primary variables.
   - Controls, instrumentation.
   - Waste disposal, pollution data, special venting methods.
   - Materials of construction.
   - Material balance summary, yields, byproducts.
   - Process and engineering flowsheets.
     - Hourly, batch quantities—weights, moles; time cycles.

D. Safety considerations.
   - Hazards—fire, explosion, health.
   - Procedures.

E. Preparations for startup.
   - Cleaning, flushing, hydrostatic testing.
   - Mechanical checks and preliminary operation.
   - Lubrication of valves.
   - Final drying and/or purging.

F. Operating procedures.
   - Normal operations—startup and shutdown
     - (Standard conditions, flows, etc.)
   - Data to record, log sheets.
   - Emergency shutdown—what to do if various situations develop.
   - Samples and process control analyses.

G. Description of utilities.
H. Description of process equipment.
   - Types and purposes, maintenance aspects.
   - Operating characteristics, inspections.
   - Instrumentation specifications.

I. Miscellaneous containers, labor needs.

Who Prepares the Manual?

The Operating Manual can be prepared in a number of ways, depending upon the way the over-all project is being administered. In the case of a turnkey plant, designed and constructed by an architect-engineer, the contractor normally provides operating manuals and other necessary supporting data.

For new plants developed within the corporate structure, process engineers, development and research scientists, along with production personnel, will cooperate to prepare the various sections of the manual. Preparation in this case is directed by the project engineer or by some man to whom he may delegate this responsibility.

Operating foremen can prepare major sections of the Operating Manual, particularly detailed Standard Operating Procedures. We have found that this provides good basic training to the foreman who is then better equipped to instruct the operators.

Often a down-to-earth operating viewpoint can be incorporated into the procedures that otherwise might be missed when process engineers with less operating experience prepare the manuals. Other things the foreman can contribute to the Operating Manual are simplified flowsheets and equipment layout sketches that will serve as training aids.

In some cases we have had operators prepare such sketches during the training program and the best were used in training operators hired after the initial crew.

Before the manual has been assembled in its final form, there will be numerous discussions with personnel in R&D, design and production to ensure that all available information has been considered and incorporated. In my experience, a major source of information has been closure engineering reports which presented laboratory background, pilot-plant results and tentative layouts and plant designs that were recommended by the development staff.

In some cases, such final reports are entitled "Process Monographs."

Getting the Plant On Stream

Where complete and detailed knowledge of the process is not available, startup planning must provide for review of all questionable areas during the period of engineering the plant. Alternate schemes of operation or installation should be recorded in case difficulties arise. Generally, where there are such unknowns, more development engineers will participate in the startup, their job being to solve problems as they are pinpointed or become obvious during operations.

During the design period, the project manager should have available one or more competent engineers with background in the process being converted from flowsheet to a productive facility. These men are expected to follow the detail designing and be certain that equipment will function as desired. The engineer-contractor (or Engineering Dept.) directing the over-all design program should automatically provide for proper specification of materials, optimum layout and safety requirements as a basic part of his job. The most economical layout, ease of operation, suitability for servicing and maintenance and, finally, general architectural appearance are representative features mentioned by Morton.[3]

Although you would hope for a well-engineered job from most engineering firms or departments, things are often overlooked or liaison between one part of the plant and another is not properly maintained. As a consequence, design deficiencies do creep in. It is up to project engineers or their representatives to review prints and specifications and eliminate as many of these as possible prior to the construction period.

Operating or production personnel should review final layouts and flowsheets before releasing the job to construction. Even while the plant is under construction, there should be continual checks of layout, piping and other installations to guarantee that no items have been overlooked. Safety hazards, operating shortcomings and similar deficiencies should be corrected if possible in the most economical manner feasible during construction.

However, it is often desirable to leave the deficiencies stand until the area has been completed by the contractor and turned over to the production department. Then, any revisions indicated can be made during the final check prior to plant start-up.

Construction Followup

Engineers and operating personnel who will be associated with the plant startup can advantageously aid the project in two ways during construction. First, they will familiarize themselves with the plant layout, piping, and equipment as it is installed, thereby obtaining intimate knowledge of what has gone into the plant. Second, they will be able to check prints and specifications against actual installations and bring errors or deficiencies to the attention of the construction department.

Production personnel (including foremen) can be advantageously assigned to the construction department as inspectors. Since they are familiar with plant design and anticipated performance, they can prepare significant check lists indicating where effort should be applied. Fig. 5 is an example of such a check list, also called "punch list".

Where such checking reveals that equipment is improperly located or not installed, the matter can be brought to the attention of the construction supervisor for proper action. Absence of certain critical pieces of equipment can likewise be pinpointed for expediting service by purchasing.

Operating inspectors can work closely with construction in checking out such units and advising on best application of manpower or crafts. Finally, operator-inspectors can participate jointly in the inspection and testing of equipment, prior to turning it over to operations for initial startup.

Avoid Unnecessary Changes

The construction superintendent will cooperate readily on installing the plant according to prints. But he may become adamant when revisions or modifications are proposed. These mean delays to his basic schedule. And change orders mean extra money, especially if a fixed cost contract prevails.

Contractors usually charge exorbitantly for deviations from the contract.

Any design changes suggested for performance, economy, improved operability or safety should be communicated to construction through a single individual representing operations. Having several people submit change requests to several supervisors in construction can be chaotic. Decisions which may involve delay in the construction program or increased costs must be cleared by the construction superintendent with the project manager, who in turn must weigh the advantages of changes against any resulting delay or additional cost to the over-all program.

Construction and operations men may also differ on scheduling completion of integral parts or units of the total plant. More often than not, construction scheduling calls for completing all units of a plant at about the same time.

Since it is advantageous to check out and operate in simulated manner certain portions of the plant before the whole is tied together, every piece of equipment that can be checked out, operated and kept "idling" should be taken from construction as soon as possible. You can correct design deficiencies or oversights that may show up during this checking period before the over-all plant startup begins.

At the very start, operations should work out with construction an area package priority system. Under such a plan, items of equipment or sections of the plant that are to be considered as discrete units will be designated.

Necessary utilities would be provided to these areas so that operating work could get underway, even though other portions of the plant were still in earlier phases of construction.

Once the "package" concept has been accepted, the construction department will count on operations to supply "punch lists" on individual units so that proper action can be taken to meet both construction and startup schedules.

Spell Out Responsibilities

Still another region of potential conflict between construction and operations relates to details of equipment flushing, cleaning and pressure testing. Specifications should be established on these items as part of original construction contracts. Responsibilities of the contractors must be carefully defined.

Production people will follow some of these activities to insure that all specified work is done. In this case, you must establish a mutually approved system of doing the work and accepting it as satisfactory. Close coordination is essential; otherwise, confusion and inefficiency will prevail.

We have found it desirable to have a foreman and crew of men from the contractor assigned temporarily to the operations supervisor in any area which has essentially been completed. They can complete details on the check list and handle any other minor points indicated by the production department.

If such a scheme cannot be set up, you can accept the area as it stands and have maintenance crews work with the production group on those items that require action. In this case, by working under a "beneficial occupancy" agreement, there should be no conflict between craftsmen of construction and those of the plant maintenance department. However, to prevent any jurisdictional conflict, you must outline quite specifically the areas of responsibility involved. It is important to point out that construction as per prints and specifications has been completed, and that the work now being handled by maintenance is checkout, corrective and operational.

Some Changes Inevitable

But operating and construction people should realize that completing plant construction in the shortest time possible means money to the company. The longer construction is delayed, the greater startup costs will be. It is for this reason that changes to the original plant design should not be made if it means a significant delay.

But the plant must be built to run, so some changes may be needed regardless of delays.

During construction, the project manager must consider means of reducing time, or at least holding to the original schedule. Overtime or bonuses for construction workers can help to speed up the program. Installing tarpaulins, or using polyethylene sheeting to enclose exposed areas will help get the job done despite poor weather.

Scale models are helpful during the plant design period, but not too useful once plant installation is well underway. Long delivery of key equipment is another cause of delay. Consequently, design specifications on items expected to have the longest delivery should be completed first so orders can be placed earliest —well before construction starts. Improving delivery dates is possible but not probable. More often, it is a major problem to hold vendors to original dates.

While the plant is under construction, the project manager will be responsible for many other phases of planning for startup. Raw materials and operating supplies, spare parts and stores items will have to be ordered.

Delivery time will have a bearing upon the amount of material ordered for initial use and storage. The purchasing department will be instructed regarding specifications and quantities of raw materials required at a particular time. Design considerations will determine that there is adequate storage space in the plant for all raw materials.

Plant startup is extremely vulnerable to delays from equipment breakdowns. Rigors of initial operation, rough handling by inexperienced operators and exposure to excessive dirt and other contamination from construction cause excessive equipment damage. Thus, you must have adequate numbers of spare parts before the plant starts up. On the basis of experience, maintenance and operating department supervision will establish what spare parts should be placed

Punch List Helps Find Errors and Omissions—Fig. 5

PUNCH LIST, AREA "A"

Reactor 425-02

1. Flush bottom valve hand wheel missing.
2. Waste slurry pump suction drain pipe should have ¾" sample valve.
3. FO-10 and 7 flanges not torqued.
4. PI-18 hose connection not installed.
5. Install valve on N2 inlet.
6. Install slurry pump motor coupling guard.

Compressor 402-02

1. Plug Hi-point vent on oil separator 421-04.
2. Distance piece oil piping not complete.
3. Grouting in base not done.
4. Install belts and guard.
5. Install suction filter and PI 73.
6. S.C. 2 and valve missing.
7. PI 17 missing from line ¾" G-5-2-267.
8. Complete insulation of aftercooler.
9. Install line 1" L-1-6-238.
10. Complete ¾" vacuum line.

Product Storage Tanks

1. Install 3 blanks on top of both 2B-401-05 and 2B-401-06.
2. Tighten flange of 401-06 pop valve.
3. Tighten bolts on FO 5 and 6.
4. Check all flanges for missing nuts and bolts.

Purification Column

1. Weld nipple in 1" S.S. valve at top of column.
2. Column thermocouple missing at top.
3. Install sight glass in reflux accumulator.

on order while the plant is under construction. Mechanical seals, packing, compressor and pump parts, spare valves, equipment parts and other replacement pieces should be on hand by the time plant startup is scheduled.

If plant design has been able to specify uniform types of pumps or valves and so forth, it will be possible to reduce the volume of spare parts required. The interchangeability possible will significantly reduce costs of spare parts inventories.

Don't Forget Inventories

Each plant requires a minimum inventory of miscellaneous stores items. Maximum and minimum quantities of these should be established and materials inventoried in preparation for initial startup. The larger the plant, the greater variety of stores items will be involved. Where a new unit is being installed within an existing larger plant, and stores and warehouse supplies already exist, it will only be necessary for the project manager or his designee to specify additional requirements.

Whenever a new plant or department is established, a new chart of accounts is essential to collect costs that will be incurred during operations. This is a simple matter but a very necessary one. Representatives of the accounting department can integrate the new cost accounts into existing systems. Arrangements will be required to revise proration of services or utilities to the various operating departments of the installation if the new plant represents an addition to an already existing layout. Where a totally new plant is involved, a complete chart of accounts must be established.

During the design period, the project manager will be looking at possible waste disposal or air pollution problems. He must consider local and federal regulations that may be involved and assure himself that the project is sound in this respect, since legal action can handicap or actually close down plant operations.

When a new installation is created within a going plant, there are many features that the project engineer must cover with regard to services to be provided by that plant. For example, assignment of maintenance personnel, laboratory, accounting, purchasing, and personnel services, utility arrangements, proration of costs, and similar activities, will have to be clearly defined.

In a completely new plant, all such services will have to be provided. In this case, you should select an administrative manager early in the program to plan such functions and line up personnel.

You Must Sell the Product

Finally, the project manager should develop with the sales department a schedule for product shipment. Proper shipping containers, labeling methods, sales literature and many other similar features involved in the sales and distribution of products must be covered. Where scheduling is uncertain, companies may purchase quantities of the new product on the open market to initiate early sales to customers, particularly if long-term contracts have been established and delays in delivery are imminent.

In the case of new products, existing pilot plants may supply initial market sampling and limited customer needs.

Beyond this, the plant must produce.

Startup Work

After plant construction has been completed and units are turned over to operations, we are ready to carry out final preparations and proceed with actual startup. During this period, we make mechanical checks, activate utilities, flush, purge and pressure test. Safety inspection of the unit is made and, if time is available, simulated operations are conducted for training and equipment performance check. Construction and maintenance may do some of these jobs jointly, particularly checkout of mechanical units and activation of utilities. Equipment that tests out satisfactorily in this joint approach is left in readiness for subsequent operations.

Let us now consider in more detail what is involved in these final moments preceding startup.

Mechanical Checkout

Mechanical checkout assures the operating man that moving equipment such as pumps, motors, compressors, conveyors and agitators, has been properly installed and that it will perform satisfactorily. Scheduling such work in advance, according to Hansen,[10] permits preliminary run-in and adjustments without delaying over-all plant operation.

What specifically should you do in the checkout program? Put machinery into limited service following vendor's instructions and operate it for a sufficient time to show that the installation will probably perform as designed. Observe general operating characteristics, lubrication, automatic controls and similar features. Make required revisions at this time.

Electricians will determine that motors rotate in the proper direction and will see that correctly sized heaters are present in starter motor-controls. Automatic tripout devices will be checked once in the presence of operations and construction to be certain that they function properly. Prior to actually turning motors over, be certain they are suitably dowelled and aligned and are dry. No-load running tests to establish temperature rise and bearing performance should then suffice.

Before turning over under regular drive, internally inspect pumps, bearings, compressors and turbines with close-clearance moving parts that are vulnerable to damage by dirt or foreign objects.

For example, in a recent plant startup, inspection of a large gas compressor revealed rust and scale from piping tie-ins plus a welding rod and small wench within the cylinder proper. In this case, routine removal of valve plates or covers for quick internal inspection prevented real trouble.

Review Procedures

Before starting compressors, the vendor's operating procedures should be carefully reviewed. Preliminary turnover may be on air with suction and discharge disconnected. Either the contractor or, preferably, the vendor's representative will supervise the startup. Representatives of operations (and maintenance) should certainly participate in this phase of the job.

One of the key points to note around compressors in particular during this checkout is vibration of

associated piping or of the foundation proper. Dirt will frequently plug lubrication lines, resulting in overheated or damaged bearing surfaces. The experienced operator watches temperatures closely, listens for unusual noise and stops frequently enough for cleanup so serious trouble cannot occur.

We take a similar approach to mechanical checkout of centrifugal compressors, blowers, vacuum pumps and turbines. After machinery inspection, auxiliary services and instrumentation are activated. Units are turned over at no load, then given light load performance checks. Frequent cleanup or inspection of lubricating systems during checkout is warranted to forestall excessive wear or premature damage.

Take particular care with mechanical seals to see that seal faces are clean and that there is a good supply of seal fluid or lubricant. Frequently, mechanical seals require a running-in time to stop minor leakage by wearing off variations in the seal faces.

Operation for a specified period of 4 to 24 hours may be required as a part of the checkout. If the normal process fluid is not available, use water for pumping as long as there is no danger of contamination or freezing. In some instances, you must consider the specific gravity of the design fluid if you substitute other liquids. Pumps run for the first time should be watched for high bearing temperature, stuffing box heat, vibration and leakage.

Before checking out pumps, provide suction screens to remove any extraneous material that might enter the pump body.

During internal inspection of tanks, reactors, and other large-scale equipment, check the condition of agitator blades and other equipment that is normally rotated from outside. Check clamps or supports for thermowells, baffles and other similar parts for tightness. In towers, when possible, check that bubble caps are in place and trays are clean.

Vendors' representatives should be present for checking and running in units as soon as installation is complete and operations is ready to take over. Auxiliary units and piping should therefore be completed and serviceable to allow any calibrations or adjustments that the vendor's representative may want to make. He may also assist in the training of operators or maintenance men.

Such service can be obtained in various manners. In some cases, the service comes as a part of the purchase price of the equipment. Warranty and service for 3 to 12 months may be included. Examine guarantees to see what service is due. In other instances, there may be a fixed fee for servicing or, more commonly, a cost per day plus travelling expenses is charged to the company. An average price may run to about $75/day plus travel and expenses.

Check Instruments, Too

There are a number of basic steps in the initial checkout of instruments. First of all, you must check leads from the field into the control room for continuity or clarity, to be certain that air lines or electrical connections are properly tied in at both ends. Blow out pneumatic supply lines during these checks. In particular, see that pneumatic transmission lines are tight. Instrument mechanics should see that there is proper action or direction of travel of motor valves in the instrument control circuit.

After all piping has been purged, cleaned and flushed out, and before operations are ready to begin, install orifice plates in the proper flanges. Install rupture disks and thermobulbs which have also been omitted to this point.

Factory-set relief valves are frequently double-checked by the maintenance department or an instrument group prior to final installation in the plant. Sometimes spot-checking will disclose improper settings, which warrants wholesale rechecking. Valves in most critical services are those normally checked a second time in this manner.

Make potentiometer and thermometer cross-checks to be sure that temperature recording and controlling instruments are properly installed. We often find that connections will loosen or contacts on thermocouples will rust during construction, thereby affecting instrument performance.

As units are brought to operational status, mechanics should check for leakage at control valve packing. Take particular care in tightening such packing, since too much pressure could damage superfinished stems. Also, do not tighten to the point where excessive friction on the valve stem will hamper proper control action.

Revisions During Construction

During construction, certain changes to piping layout or modifications in other installations may be indicated. These changes may be necessary because of oversight in design or checking of the installation or they may be recommended as the result of additional laboratory or development information.

There are two general approaches that can be followed to incorporate revisions. First, you can prepare a change order for the construction group, advising what to install or revise even as plant construction proceeds. Or it is sometimes preferable to wait until the unit has been turned over to operations and then have maintenance do the work.

The first approach may involve price negotiation if a fixed price contract is in effect. Costs may be excessive or the revision work may drag on as construction workers try to make their assignment last.

We prefer to do the necessary work with operating-maintenance personnel if at all possible. Such work can be scheduled at the same time the preliminary testing and final checkout is under way.

You must be careful in deciding which revisions are necessary. There is a tendency for operating people to see all sorts of improvements as the plant is being completed and they may insist that such changes are essential to safe or suitable operation. The project manager, or his designee, must screen proposed revisions very carefully so that there is no excessive backlog of revision work.

If a plant has been designed properly with the operating man's viewpoint properly considered, it should start up as designed even though further improvements are warranted. Changes that are considered desirable can be made later on to improve efficiency or quality but the important thing is to get the plant into production rather than delaying time after time for revisions which "just have to be made."

Pressure Testing

Pressure testing of piping and equipment is necessary before

starting, to assure that no leaks exist and that equipment will structurally withstand operating pressures. It is usually the contractor's responsibility to conduct a hydrostatic test to satisfy these requirements.

Pressure test before painting or insulating and take every precaution to insure operator safety with appropriate gages and safety valves.

Although the vendor tests much of the prefabricated process equipment prior to delivery, it is often good practice to include such items in a "package" system being tested in the field. You may have to block off certain units or sections during a test to protect them from damage by high pressures.

For example, leave out or blank off pumps, compressors and turbines, rupture disks, relief valves and certain in-line instrument components until the test work is complete. Lines normally carrying vapors should have spring supports blocked before adding water. Expansion joints may have to be blocked or isolated. Install temporary strainers to prevent carryover of scale or rust into sections where they cannot be tolerated. No water should be allowed to enter compressor cylinders, pumps, blowers, instruments or lines. Set control valves in full open position.

It is a common technique to segregate a plant or area into test packages that can be checked conveniently as a unit. This speeds up the testing program by reducing the number of isolation points.

Also, insulation work can follow on the heels of testing work as packages are completed.

You can follow progress during a testing program in a number of ways: (1) tag lines, valves and sections as they are checked out as satisfactory; (2) mark completed sections on a piping print; or (3) tabulate lines and equipment as tested and have initialled "OK" by inspector when done. The last method is best for the records, but may be too time consuming.

Some Testing Guides

As a rule, testing follows these or similar guides:

(a) Hydrostatic test at 1.5 times maximum working pressure for a minimum of 4 hours, usually to a minimum of 50 psig.

(b) Pneumatic test at 1.1 to 1.5 times operating pressure, but usually not exceeding 100-125 psig. maximum (primarily for safety reasons, but also available plant air supply normally does not exceed 125 psig.). Minimum is 25 psig. unless otherwise specified. Leak test by soap bubble method or hold test.

(c) Halide leak test at design pressure to maximum 100 psig.

A hydrostatic test may be applied to a fully vented system, usually by positive displacement pump. Pressure is not applied until the system is at reasonable temperature equilibrium. Leaks reveal themselves by drop in pressure or by visual evidence of leaking water. Systems should have proper venting to insure against collapse by vacuum during draining of water. The same vent expels air during filling. Lines where traces of moisture from hydrostatic testing would be detrimental, such as instrument air, refrigerant and nitrogen lines, are usually checked out pneumatically.

Use air pressure testing where water might cause corrosion or freezing, or where the weight of units filled with water would exceed foundation design.

In a standard air pressure test, lines are brought to about 50 psig. (or lower if so designated) with dry air; the system is isolated, and leaks sought by sound (if large), by soap-bubble testing, and finally by hold test. After major leaks are corrected, proper test pressure is applied and held about 3 hr. to ensure that no leaks exist, as evidenced by a drop in pressure on a suitably calibrated gage. Pressure loss greater than 2 psi./hr. is normally considered excessive.

Halide Leak Testing

For halide leak testing, the equipment is pressurized to about 10 psig. with Freon or similar halide-containing gases, then brought to test pressure or a minimum of 50 psig. with diluent air. Joints are checked with an electronic halide detector or with a flame detector. These special devices require practice in their use because interference by foreign materials is common, particularly with the electronic unit. Testing should be in a relatively draft-free area and the air must be clean in the vicinity, since the detector is responsive to smoke, paint and fumes.

After construction has completed its agreed-upon testing work, have operators double-check the system for leaks if time permits. This is preferably done with inert gas or air pressure techniques. Operators can be assigned to leak testing as a phase of their field training, since following lines in detail is an excellent way to learn the system.

Practical Hints

Here are a few practical observations worth noting:

1. For soap-bubble testing in freezing weather, we have found certain undiluted liquid detergents entirely satisfactory. Ordinary soap and water solutions are inadequate by contrast. Application by plastic squeeze bottles instead of conventional brushing is sometimes preferred.

2. When checking gas leaks at flanges, seal the peripheral gap with masking tape and punch a small hole over which detergent can be coated. This method is also useful in other similar locations where it is difficult to spread a film of soap.

3. In particularly complicated piping arrangements, leak detection can be expedited by a visual technique. Where acceptable to the process equipment or where available in process, you can put chlorine or SO_2 into the system to be tested, and blow strong ammonia vapors against the joints. Presence of smoke or vapors will indicate even the smallest leaks.

4. In cold weather, which would prevent hydrostatic testing, kerosene or similar hydrocarbons are excellent substitutes for water. The same procedure is applicable where residual water or slow drying out could not be tolerated.

5. There are several techniques for removing water from a system after hydrostatic testing:

a. Blow extensively with air, preferably dry air.

b. Blow with anhydrous gas or with a superheated gas.

c. Heat the equipment externally.

d. Flush with hygroscopic or water-dissolving solvents such as methanol or acetone, then evaporate residual solvent by blowing.

6. In testing process equipment that was to handle a pyrophoric, liquefied gas at —50 F., final pressure testing was done while processing liquid ethane through the system. The joints shrank, and tight-

ening while cold eliminated leakage under operating conditions.

7. When you find many poorly machined or roughened flange surfaces and chronic leakage, specify that gaskets be coated with one of the proprietary gasket seal materials. This will fill imperfections in the flange faces and give a good seal. However, excessive "gasket seal" is not a substitute for clean flanges or properly aligned joints.

8. All oxygen service lines must be degreased after hydrostatic testing and drying. Solvents such as trichloroethylene circulated or flushed through piping will do this. Final blowing with dry air will remove the solvent.

Cleaning and Purging

Upon completion of construction, and preferably after pressure testing, equipment and piping must be flushed and cleaned. Such action to remove foreign objects, mill scale and dirt will significantly reduce operating problems during startup.

Flushing with water is conveniently done as hydrostatic tests are completed. Allow water to drain freely from all possible openings and charge additional water to be certain that all points where dirt is apt to accumulate are thoroughly flushed. If there are not sufficient drains for satisfactory flushing, break open existing flanges, remove fittings, or even install new drains.

Piping systems may alternately be flushed by blowing out with air. Where the air supply is limited, lines and equipment may be cleaned with steam. In this case, grease, oil or other organic contamination will be stripped out more readily.

Operators should watch for obstructions or restrictions in lines, valves and drains. The proverbial coveralls or lunch boxes (or more likely, insulation, welding rod and slag, wood scraps, bolts, fittings, stones, etc.) must be removed to assure suitable equipment performance.

You can remove most such items with proper manipulation, but occasionally visual inspection and dismantling may be required.

Systems should be flushed until inspection of strainers or screens shows adequate removal of dirt.

Where possible, open control valves to remove scale that tends to collect behind the seat. Remove plugs or bonnets from valves in place to check for cleanliness or obstructions. Check valves by opening and closing carefully and see that proper packing and lubrication are provided.

Certain process systems may require more stringent cleaning before operations can be started. Examples are refrigeration systems, where residual water, scale or dirt would be harmful to turbines or compressors; a chemical process, wherein mill scale causes catalytic decomposition of the product (hydrazine); oxygen piping, which must be degreased prior to use for safety reasons; and potable water lines that must be sterilized.

Zero Hour Approaches: Will It Run?

Try Chemical Cleaning

Degreasing solvents such as trichloroethylene or perchloroethylene may be charged to a storage vessel in the process loop and circulated three or four times through equipment. Caustic soda solution (10%) at 160 F. has also been employed by circulating 15 minutes and flushing with hot water to remove traces of the caustic. For removal of scale or rust, chemical cleaning with inhibited acid solutions is conventional. Portable tanks and pumps are suitable for cleaning operations, particularly in small systems.

A process solvent circulated through equipment before startup will give good cleaning action. Simulated operations have the same effect.

In all cleaning operations, sections of lines between temporary or permanent strainers and the equipment being protected should be carefully wiped out, wire brushed or otherwise cleaned. Suction lines to compressors should have swabs or "knockers" run through to remove scale and other material that would score cylinders if carried into compressors. It is essential to blank off compressor or engine cylinders during hydrostatic testing or flushing to protect against water contamination.

Orifice plates should not be installed until fluid lines have been flushed and drained. Instrument air lines must be blown thoroughly before introducing air to the instrument itself. Be sure to tighten connections after this step so that instruments will perform properly when put into service. Such cleanup can be accomplished at the same time instrument mechanics are checking continuity or "clarity" of lines and circuits between field and control room or panel boards.

It may be necessary to purge or displace air from the system when the presence of air in the process stream represents a hazardous condition or affects the process chemically. Best approach is to purge the air carefully with natural gas, venting through a flame arrestor to

atmosphere via a stack or directly to the air, taking wind direction into consideration. The job should be done slowly since speedy purging may cause welding slag to be picked up and strike sparks as it rattles through the lines. Explosive mixtures which could exist during the purging might then be ignited. Flushing gas through low points first and then finally through high vents is the preferred technique.

Simulated Operation

When equipment in a new unit has been installed and checked out as mechanically satisfactory, it is a desirable practice, if possible, to carry out some form of simulated or mock operation. The plant can be checked out in segments or stages under this scheme, then integrated into the total process.

During such a dry run, nonprocess materials—water, steam, air or other suitable fluids or even solids—would be charged and worked through the equipment. Often, it would be just as convenient to use some of the actual process materials, but omitting any expensive, hazardous or otherwise undesirable items.

Such preliminary operation constitutes a final dynamic test before actual processing begins. It gives proof that installation is proper and that machinery is operable and will run continuously.

Another approach carries out the proposed operation but omits or by-passes a critical condition, such as not charging catalyst or imposing temperature or pressure conditions that would not affect the reaction.

As Eames, et al.,[5] point out, materials similar in composition or properties to those that will later be processed may be substituted in the more sophisticated simulated operation. Synthetic mixtures, for example, can check out separation steps.

During simulated operation, instrument and valve settings can be set, heating and cooling services adjusted and general performance characteristics of units established. An added advantage is that equipment will be more thoroughly flushed, so that when bona fide operation does get underway, problems due to contamination and dirt will be significantly reduced. Often, initial checkout of pumps, compressors and similar equipment can be done item by item, by operating in a simulated manner.

A "dry run" is also of great value to operators who are becoming familiar with the plant. It discloses defects in machinery and piping while there is still time to correct them. Typical problems may arise that can be corrected more readily and economically than when actual process materials are present. As an example, the author has checked out conveying equipment on common salt (NaCl) before more expensive and corrosive rare-earth salts were introduced.

Management considers the time expended in such phases of the startup program as a luxury in the face of pressures to get a plant into productive operation. However, advantages already mentioned, along with the prime opportunities for operator training, make this step in startup worthy of consideration.

Final Preparations

When all testing and checking is complete, the new unit should be ready for operation. A schedule for shift operations will be put into effect if it is not already being followed by this time. Arrangements will be made for extra maintenance mechanics — particularly fitters, millwrights, instrument men and electricians. Any manufacturers' representatives required to assist should also be scheduled.

Though thousands of details are checked out before initial operation, something will be overlooked. A final check list helps in reviewing the status of the plant and its readiness for operation. Items on such a list should be covered by key people concerned with maintenance, operation, quality control and technological aspects of the plant.

A last minute planning conference or series of sessions will be held with shift foremen, key production engineers and supervisors to reaffirm the method of starting productive operation. Special assignments to follow the operation of individual pieces of equipment, particular units, or plant areas are often given during such conferences to process engineers or to extra production supervisors.

An excellent pre-operational check-list has been summarized in an article by Eames et al.[6] This is all-inclusive, covering the gamut of activities from the general plant check-testing, commissioning of utilities and equipment, to final preparation. I have used similar lists, but prefer to concentrate on the final pre-startup items.

Table VIII lists items which I have found important in making a final check before startup.

Do Not Overstaff

Be sure to cover the job with enough competent supervisors, engineers, operators, mechanics or specialists, but do not overstaff. Too many experts may confuse the program. Establish clearly the responsibilities and lines of communication so that there will be no boners —or shall we say a minimum of boners. Vendors' representatives should be on hand as long as required; however, just as soon as company engineers are able to, they should take over.

During the planning session, individuals may be assigned responsibility for particular pieces of equipment. For example, one process engineer may handle a reactor and associated equipment while another may handle the product stream through a series of purification stills. Each man will check on final operator training for his unit. He will oversee final mechanical checking, simulated operation and other preparatory work.

Where an operation demands 24-hour attention, the engineer may follow through his responsibility with shift foremen or other engineers who will cover as his relief. A period of several 12-16 hour days or several weeks of 6-7 days each, may be the lot of the project engineer following startup.

Close teamwork is essential, to be certain that the total job is not faulty because of a weak link. The plant superintendent or production engineer must be vigilant during this period, watching for delays, anticipating difficulties and solving problems as they arise. The more complicated the unit, the more essential the need for a careful startup schedule.

Urgency to get the plant on stream often necessitates special arrangements whereby both operating and construction activities are underway within confined areas. To minimize conflicts, much of the operating work can be done on off-shifts by following an around the

clock schedule. During the day, operations can be held in abeyance or blocked in as required.

Since integrated operation is not possible until successive steps have all been checked and put into functional condition, some production groups prefer to delay startup until construction is essentially completed. This may reduce startup costs, but is apt to lose time.

Don't Forget Samples

Operating personnel should work out with the control laboratory precise details concerning samples. It is imperative that a representative sample be taken, and that the sampling lead be properly purged each time. Very often, process operations are altered on the basis of analytical results that, on further checking, may be found erroneous, so it is good practice to run double samplings any time there is an indicated discrepancy from what common sense dictates should be correct.

Final review should be held on all alarms installed on equipment, and action prescribed to correct situations which initiate the alarm. Procedures to follow when general emergencies arise should also be covered. Expected emergencies should be simulated during dry runs.

You must know where spare parts and supplies are located and be certain that adequate supplies are on hand. Certain ordinary things that are usually taken for granted, and therefore often overlooked, merit a review at this point. We consider these:

1. Custodial Equipment—Where gas masks and other protective equipment are required, it is essential that every operator be properly fitted out before real operation gets underway. Such things as gloves, boots, coveralls and other custodial equipment, where they apply, must not be overlooked or forgotten.

2. Hand Tools—Although operators may not qualify under union regulations to do maintenance, a few special hand tools will facilitate operation in many ways. A typical set of such tools would include an 8 or 10 in. crescent wrench, 8 in. pipe wrench, pliers or channel locks, and screw driver. These or equivalent tools will be valuable to the operator for such jobs as taking up on valve packing nuts, tightening ferrules or small fittings, turning valves that are otherwise too tight, tightening leaking flanges, and minor dismantling jobs.

3. Miscellaneous Equipment — Have plenty of general-purpose hoses for utilities or process jumper lines, plus necessary quick disconnect fittings. In emergencies during initial operations, it is often necessary to apply steam, water or air, or to bypass some section of a line. Flexible hoses are admirably suited for such applications.

A cylinder of nitrogen gas and associated fittings finds many applications. Very often a section of line must be purged or a plugged section blown out. Careful use of high-pressure nitrogen may eliminate extended shutdown and dismantling.

If there are a considerable number of pumps in a process unit, a spare portable unit may be a wise investment. A high-speed centrifugal with a reasonable head would be most versatile.

Other common items that should be available during plant startup are pails or drums. There are many occasions where material must be drained from a line, conveyed from a sample point or used to prime a pump. Here, ordinary galvanized, rubber-lined or porcelain-lined pails, and plain steel, open-top or bung drums serve very well.

Miscellaneous solvents and chemicals are also useful during plant startups. For example, methanol is valuable where freezing of hydrocarbon hydrates in lines may cause plugging, and Freon for leak detection should not be overlooked.

A hydrostatic pump intended for pressure-testing is handy for unplugging lines.

An intercom system between control room and key spots in the process area permits immediate checks on instrument performance, levels, flows and other process observations by lead operators. It is particularly helpful in directing trouble-shooting crews from the control room.

Don't forget grease guns for lubricating valves, bearings and seals. Have as many as required by variety of lubricants or applications.

Liquid solders or seal compounds are invaluable for stopping leaks in pipe fittings and gasket flanges. Liquid solder used on cracked castings and leaks can eliminate extended shutdowns.

Have plenty of miscellaneous fittings, gaskets, packing, standard valves and pressure gages.

Drying compound is a must where oils and other process materials would create sloppy and hazardous floor conditions.

Miscellaneous lengths of pipe or rod are essential for rodding out or washing out sections of pipe, or for access to equipment.

4. Equipment Identification — Pipe lines, vessels and other process equipment are frequently marked to indicate flow, or identify content right after construction is complete. If not done earlier, identification should be done by operators under the supervision of foremen and engineers during the final check-out of the plant. Although operators should know their equipment reasonably well by the time startup is underway, confusion may develop during the night or in emergencies. Quick identification of lines and equipment in such a situation makes the solution of a problem easier.

5. Ladders and Other Means of

Final Checklist Ensures Orderly Startup—Table VIII

1. Planning conference to consider over-all status and responsibilities.
2. Scheduling of shift and unit assignments.
3. Preparation of unit-operating schedule.
4. Availability of supplies, spare parts, miscellaneous aids.
5. Coordination with other departments or units where applicable.
6. Setting valves, instruments, utilities, etc., in proper sequence or condition.
7. Install rupture disks, orifice plates and other final items.
8. Install temporary lines, hoses and bypasses needed for startup.
9. Raw materials available and charged.
10. Log sheets, operating manuals and operating check lists ready.

Access—During startup, operators may have to reach valves or other pieces of equipment that are not readily accessible. In the long pull, such equipment ordinarily will not have to be operated or maintained. However, for startup, you should provide ladders, temporary platforms or other means of access so that the startup can be handled in a safe way.

6. Portable Compressors and Vacuum Pumps—It might be convenient to have a portable air compressor or a vacuum pump available for special operations.

In each plant startup, similar needs for specialized equipment may be worth considering.

The Human Factor

A successful plant startup is as dependent on the diligence, competence, know-how and aggressiveness of the people involved as it is on the equipment and process. As we have mentioned repeatedly, proving out a new plant or process is ordinarily a tougher job than keeping an established operation on the line.

Therefore, you should have available at such a time the benefit of as much operating experience as possible. Engineers, supervisors and operators who have previously participated in startups are expected to have the necessary background. Their knowledge of shortcuts, special operating techniques and miscellaneous tricks of the trade that they have accumulated over the years is invaluable during startup. It is for this reason that many companies maintain "flying squads" of experienced plant startup experts of all ranks.

But how can you obtain such practical know-how when experienced personnel are not available? Plant manuals or operating procedures may include many helpful techniques. Some are available through publications as notes, feature articles or columns in trade journals. Vendors' literature often contains an abundance of pertinent operating and maintenance information. However, the preponderance of operating know-how seems to be transmitted verbally from generation to generation of operators and engineers.

Never Give Up

Operators should not give up easily, since it may take just a little extra push or a little more time to get an operation on stream. Bear in mind that if you cannot do the job, someone else will find a way—or will find someone else who can do the job.

Often, common sense will solve a problem where a complicated approach was first indicated. In smaller systems, for example, temporary bypasses made from hose or copper tubing can be used to get around a plug or isolate a leak.

There are many, many other similar operating tricks accumulated over the years that can help ease the way in a plant startup. We have hinted at some of these.

But our aim here has been to concentrate on the organizational, personnel and mechanical aspects of starting up a new plant. We have tried to show you the infinite attention to detail that coordination of a plant startup requires. We think we have succeeded in our effort.

(Our author has promised us another article or two dealing exclusively with "tricks of the trade" concerning trouble shooting and operating hints for such things as distillation units, heat transfer equipment, pumps, valves, instruments and the myriad other items that go to make the modern plant. These will appear in early issues of *Chemical Engineering*.—Editor.)

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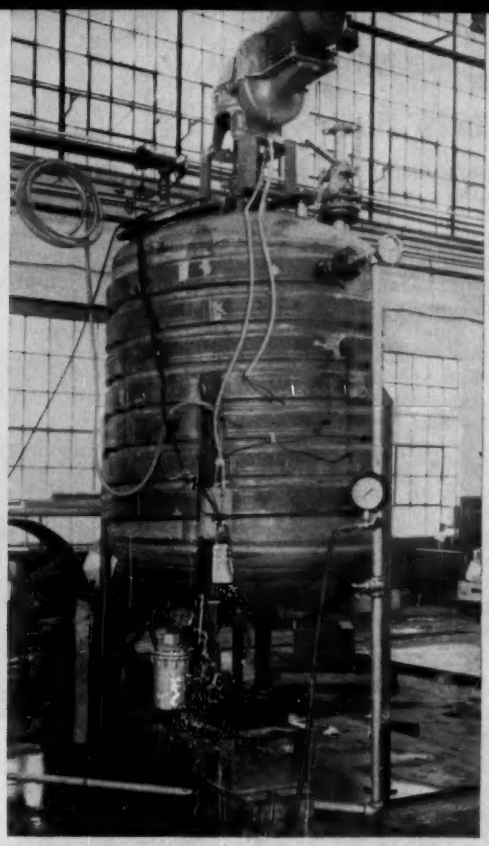
For an extra copy of this 20-page report on Plant Startups, circle reprint No. 165 on the Reader Service Card (p. 201). Price 50¢/copy.

J. E. TROYAN is well qualified to write this report on plant startup. Since 1949, when he started with Olin Mathieson as Director of Engineering Research and Development, Mr. Troyan has participated in the startup of many plants including, most recently, Olin Mathieson's Navy high-energy boron fuel plant at Model City, N. Y., of which he was plant manager. Later, he was production manager at the larger Air Force HEF plant during its startup in 1959. Afterwards, Mr. Troyan was transferred to Olin Mathieson's Doe Run, Ky., plant where he is now Production Manager.

Our author's previous experience includes Cyanamid, Gulf Research and Development, Phillips Petroleum and the Office of Rubber Director. He was also a member of the TIIC team that investigated the German synthetic rubber industry after the war.

Mr. Troyan is a chemical engineering graduate of Case Institute of Technology, a member of ACS, AIChE and Alpha Chi Sigma and holds a P. E. license in Connecticut.

New Idea in Jacketed Vessels



Reinforcing vessel with less-expensive steel jacket allows thinner alloy-steel inner wall. Cost is lower and heat transfer better than with conventional designs.

C. A. FEICHTINGER, Eastman Kodak Co., Rochester, N. Y.

During a recent design project at Eastman Kodak's Kodak Park Works, we came up against a familiar problem—designing an alloy-steel reactor to contain 50 psig. internal pressure, and to be heated with 90 psig. steam or cooled with water in an external jacket.

Past choices were few: a conventional jacketed pressure vessel with a heavy inner wall to resist jacket pressure, or a special plug-weld "stayed" jacket design. The first of these was expensive and showed poor heat transfer through the thick inner wall. The second showed a high tendency to fouling and was subject to stress and cell corrosion at the welded junctures between vessel wall and jacket. Both showed poor flow characteristics on cooling.

We rejected both of these designs and, instead, produced our own do-it-yourself reactor. The basic idea of staying the jacket to the inner wall was retained, and several designs were considered. Fig. 1 shows the design picked as a likely choice for further investigation. The channel-like members, we felt, could be simply formed on a brake and rolled to conform to the inner wall with a built-in spiral or lead. The members could then easily be attached to the inner wall by continuous fillet welding with full penetration. Flexing of the channel jacket would accommodate differential expansion.

Building a Test Model

With the design selected, the next step was to build a test model. Short pieces of $\frac{3}{8}$-in.-thick carbon steel channel were welded to a simulated section of inner shell made from the same thickness carbon steel. Wall thicknesses were calculated by the 1956 ASME Code for Unfired Pressure Vessels for a design jacket pressure of 90 psig. The photographs show the model set up for pressure and strain gage testing. Note the location of strain gages, Fig. 1.

Fig. 2 shows results of the hydrostatic test on the model. The strains ϵ are observed and the stresses S calculated from $S = E\epsilon$, using a modulus of elasticity E of 30 million psi. It is interesting to note that the pressure of 135 psi., which produced one stress equal to the estimated proportional limit of 22,500 psi., is that at which a vessel would normally be tested—$1\frac{1}{2}$ times the design pressure of 90 psi. Beyond this pressure, the strain values typically increase more than

Nomenclature

A	Heat transfer area, sq. ft.	k	Thermal conductivity, Btu./(hr.) (sq. ft.) (°F.) (in.).
b	Wetted perimeter, ft.	p	Net pressure on walls, psi.
c_p	Specific heat at constant pressure, Btu./(lb.) (°F.).	S_t	Working stress, tensile or compressive, psi.
C	A coefficient.	S_s	Shear stress, psi.
d	Support distance, in.	t	Shell thickness, in.
D	Diameter, ft.	U	Over-all heat transfer coefficient, Btu./(hr.) (sq. ft.) (°F.).
E	Modulus of elasticity, psi.	ϵ	Unit deformation, in./in.
G	Mass velocity, lb./(hr.) (sq. ft.).	μ	Viscosity, cp.
h	Coefficient of heat transfer, Btu./(hr.) (sq. ft.) (°F.) (in.).	μ	Poisson's ratio.
l	Wall thickness, in.		

proportionally. The yield stress, defined at 0.2% offset, of this material is 33,000 psi. Considerable bowing of the test area and, finally, rupture occurred at 365 psig. along the ⅛-in. metallic arc-welded bead between the channel and the shell.

Note that the plot shows stress as a straight linear function of applied hydraulic pressure up to the proportional limit. On the reasoning that a section through the shell and channel produced a uniformly loaded flat plate restrained at the ends, an empirical formula of the type $S_t = Cd^2\ p/t^2$ was chosen to represent the plots of Fig. 2. Since d and t are known constants for this design, C, the coefficient, can be calculated for the linear portion of each curve.

Applying the Test Results

Results so far were encouraging. The channel members were easy to fabricate and attach. The stresses produced in both the shell and jacket were less than one-half the yield stress at the design pressure, 90 psig. On this basis, we decided to build a 750-gal. AISI 304 stainless reactor of this design, collect actual fabrication costs, stress data and heat transfer data, if possible.

The unit was designed as follows: t_1 assumed to be 0.250-in. (+0.062-in. corrosion allowance); S_{t1} is 15,450 psi. at 400F. for AISI 304 stainless from the ASME Code; t_2 assumed to be 0.219-in. (+0.031-in. corrosion allowance); S_{t2} is 13,750 psi. at 400F. for A285C steel from the ASME Code.

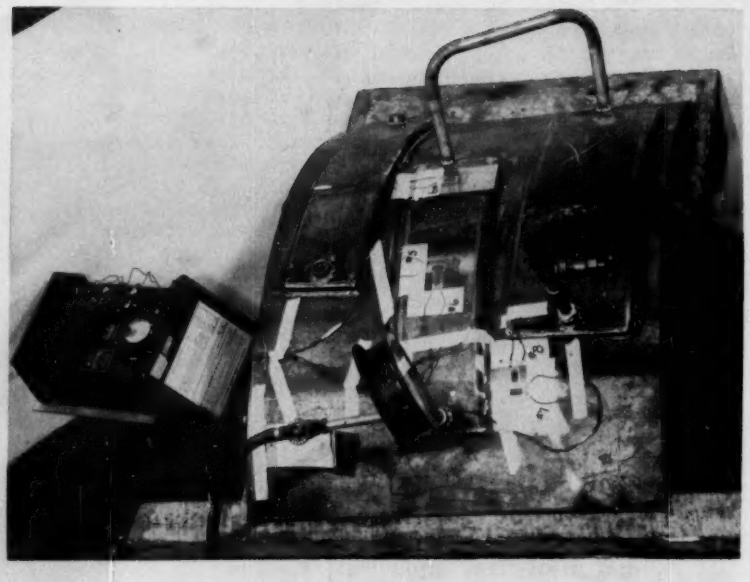
The limiting conditions for maximum stresses shall be: principal stress equal to or less than the Code S_t (15,450 psi. for the stainless inner shell and 13,750 psi. for the steel jacket); maximum shear stress equal to or less than $S_t/2$ (7,725 psi. for the inner shell and 6,875 psi. for the jacket). The maximum shear stress theory is preferred for ductile materials, and maximum shear is the larger of $S_{t1}/2$ or $(S_{t1} - S_{t2})/2$.

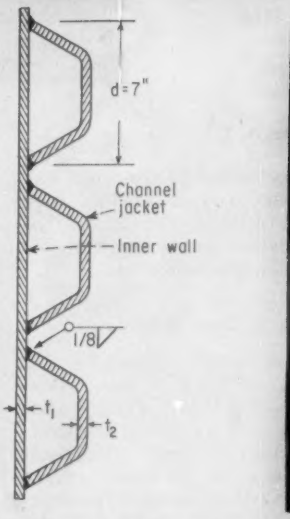
Calculation of the stresses, using the previous equation, $S_t = Cd^2\ p/t^2$, and C values from Fig. 2, showed that all met the limiting conditions. Our lead photograph shows the actual vessel built, set up for hydraulic testing. Note that location and direction of strain gages are the same as used on the test model.

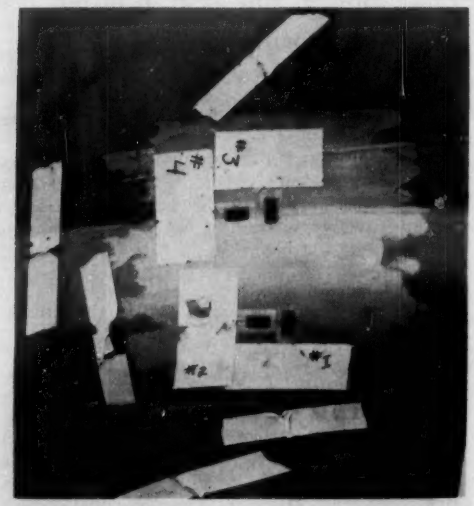
After the test, stresses were calculated again from $S = E\epsilon$ and plotted in similar fashion to Fig. 2. This time, an E value of 29 million was used for the stainless inner shell. New values of C were also calculated and found to agree closely with the test model values.

The more precise determination of principal stresses would be by applying the Poisson effect to the measured net strains and solving for $S_{t1} = E(\epsilon_1 + \mu\epsilon_2)/(1 - \mu^2)$ and, at 90°, $S_{t2} = E(\epsilon_2 + \mu\epsilon_1)/(1 - \mu^2)$. Poisson's ratio μ is 0.30 for steel and stainless steel. Here, ϵ_1 and ϵ_2 are unit deformations in the directions of S_{t1} and S_{t2}, stresses, tensile (+) and compressive (−). A comparison of the predicted stresses and the actual stresses, calculated by both methods, with the allowable stresses was prepared.

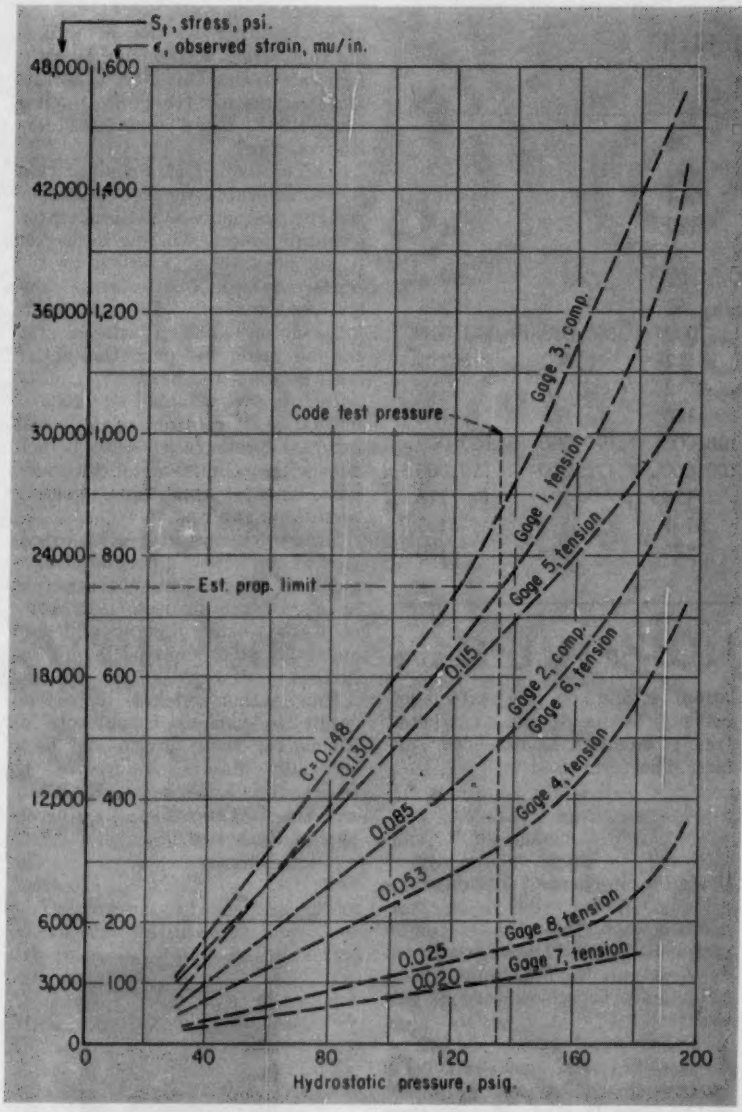
A study of the results showed that the highest principal stresses occurred at gages 1, 5, 6, 8 and the highest shear stresses at gage 1 + 2







MODEL ready for test. Top picture shows outside with pressure connections. Lower right shows inside of shell. Note location of strain gages. Diagram at lower left is cross section of shell and jacket.—Fig. 1



TEST RESULTS for hydrostatic test on model. Strains are observed and stresses calculated using $E = 30$ million psi. Values of C are calculated and indicate slopes of the straight lines.—Fig. 2

but none exceeded the design allowable values. Reversals of tension or compression for stresses on the opposite wall from that where the gages were mounted do not alter the preceding statement. For ductile materials, the maximum shear theory is preferred. Since the maximum, at gage 1 + 2, using the new values of C, is either:

$$S_s = (S_{t2} - S_{t3})/2 = K(C_1 - C_2)/2$$
$$= K(0.135 - 0.032)/2$$
$$= K(0.167)/2$$

or:

$$S_s = S_{t1}/2 = KC_1/2 = K(0.135)/2$$

then, the value of $C = 0.167$ should be used for the inner wall design because this is greater than 0.135. The value of $C = 0.12$ can be used for the jacket design.

By the purely theoretical approach as outlined by Brownell and Young in their "Process Equipment Design," stress value coefficients for a uniformly loaded circular plate with clamped edges would be 0.187 at the edge and 0.122 at the center. One can speculate that the lower (0.167) measured value against the (0.187) theoretical value might be accounted for by the greater edge restraint provided in this design.

Care in Weld Design

Great care must be taken in the fillet weld design. Assuming pressure tends to pull the channel jacket away from the inner shell, then t weld $= pd/2S$ where S is the allowable tensile working stress corrected for joint efficiency (0.6). Because of the welding stresses present at this point of highest pressure-induced stress, the root dimension of the weld should be at least equal to the jacket metal thickness.

Cost Comparison

The following is a comparison of costs for our new design vs. quoted costs for two other designs.

For a 750-gal. vessel, 60-in. ID., 60-in. straight side, 304 stainless steel inner shell, A285C steel jacket:

- Conventional jacketed vessel design—quoted cost was $7,370.
- Close plug-welded, embossed jacket design—quoted cost was $4,985.
- Spiral jacket design—actual cost was: material, $2,500; labor, $1,860; engineering, $400; total cost, $4,800.

Considering this cost was incurred on our fabrication of a new design, with extra care toward all details, we were gratified. Making the greater length of jacket weld was not difficult or prohibitive in cost.

Testing Heat Transfer

We decided to perform heat transfer tests to determine what gain was possible due to higher jacket-coolant velocities over a conventional jacketed unit. The test consisted of running a metered flow of water through the jacket and measuring its temperature rise when heated by 5 psig. steam inside the vessel. The condensate was collected as a heat balance check. Since we could accurately predict the steam film coefficient h_s, and the drop through the metal wall k/l, we should then obtain h_w,

Results of Heat Transfer Test—Table I

Test Series	1	2	3
Water flow, gpm.	36	66	87
Water flow, lb./hr.	18,000	33,000	43,500
Jacket cross area, sq. ft.	0.04	0.04	0.04
Jacket velocity, fpm.	120	220	290
Water temp. in, °F.	34	34	34
Water temp. out, °F.	93	68.5	59.5
Water temp. diff., °F.	59	34.5	25.5
Heat transferred, Btu./hr.	1,100,000	1,150,000	1,110,000
Condensate flow, lb./hr.	1,122	1,200	1,210
Steam pressure, in. Hg.	12	17	18
Steam temp, °F.	188	173	170
Heat from condensate, Btu./hr.	1,108,000	1,190,000	1,160,000
Heat used, Btu./hr.	1,100,000	1,170,000	1,130,000
LMTD., °F.	119	121	116
Jacketed area, sq. ft.	51.5	51.5	51.5
U, Btu./(hr.)(sq.ft.)(°F.)	179	188	189

the water film coefficient. The test setup can be pictured from the photo. The test values and calculated coefficients are shown in Table I.

The U values are probably somewhat low, especially for Series 2 and 3. The steam main in the shop area where the tests were made was inadequate. Notice the subatmospheric pressures in the tank during the test that required batch removal of condensate with no continuous venting of air from the tank. We suspect the tank contained a trapped volume of air that would prevent it from reaching the higher vacuums necessary for increased steam flow at the higher water rates. However, using the data from Test 1 with a U over-all of 179 and $1/U = 1/h_w + l_w/k_w + 1/h_s$, we calculated h_w, the water film coefficient. Assuming h_s, the steam coefficient, to be 2,000; k_w, the wall conductivity, to be 105; and knowing l_w, the wall thickness, to be 0.312 in.; h_w is 468 Btu./(hr.) (sq. ft.) (°F.) (in.). Note that scale effects are ignored because the vessel was new.

Checking this result with the Dittus-Boelter equation for heating fluids, altering for flow in annular spaces, gave $h_w = 412$. This is a fair check and shows that the equation could be used for future calculation, erring on the safe side. Probably some of the unjacketed area is effective as extended surface. The form used is:

$$\frac{hD_e}{k} = 0.023 \frac{(D_eG)^{0.8}}{\mu} \frac{(C_p\mu)^{0.4}}{k}$$

Design Criteria and Conclusions

Experience with the prototype vessel discussed in this article led us to set up the following design criteria for future projects of this nature.

• For vessel design, use the revised values of $C = 0.167$ for the inner wall and 0.12 for the jacket in the formula $S = Cd^2\ p/t^2$, since these values were taken from tests on an actual vessel of the same geometry as future vessels. For higher jacket pressures, lesser widths, d should be used. The jacket should have a generous radius at its corners and should meet the inner vessel at about 45°. This permits good welding with full penetration. The spiral jacket can be sectionalized for heating in one section, cooling in the other. The lower portion of the jacket is also stayed to the inner head by a series of welded-on pads and plug welds.

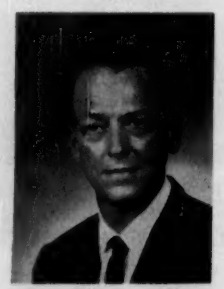
• Use the Dittus-Boelter equation for coefficients on liquid flow. The jacket channel height can be varied to suit flows without affecting shell stresses. We have recently fabricated and installed a spiral-jacketed reactor for quick cooling with −20F. brine, with considerable success.

• The cost of this construction is economical compared to other designs, and more so with increased pressure design. Welding the jacket is simple with no scarfing of the edges required. The design is valuable where inner wall material is to be conserved. The jacketed area can be made to cover the entire shell between the heads.

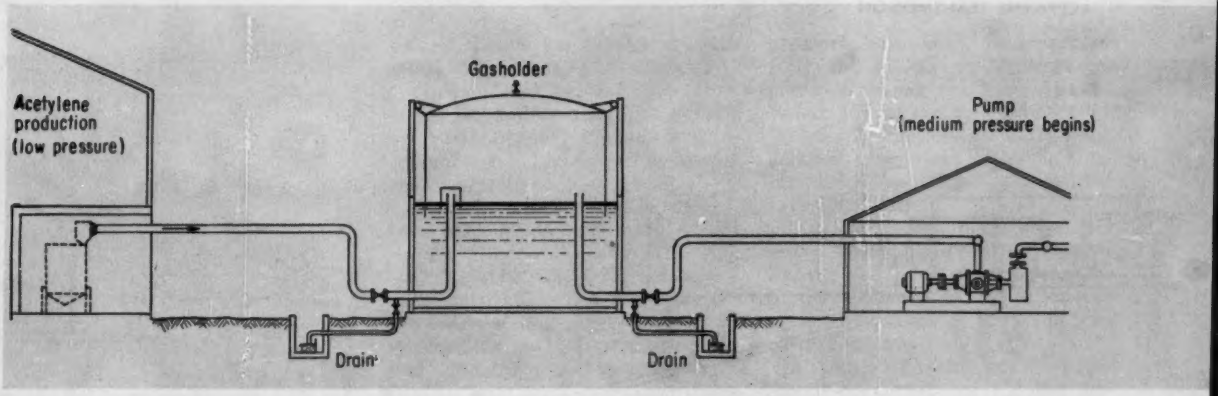
In total, we attained our goal of mutual shell reinforcing to resist external pressure collapse coincident with optimum metal thickness, heat transfer conditions, welding conditions and cost.

This work was done as an extension of the author's normal assignment of project engineering—not as a research project. Any comments on a better theoretical design approach or other aspects are solicited.

The author wishes to extend credit to various consultants at Kodak for their advice and help, especially Messrs. A. Reeves, E. Shiffhauer, J. Waskow, R. White and Dr. T. Faucett of the University of Rochester.



C. A. FEICHTINGER graduated from Washington University, St. Louis, with a B.S. in mechanical engineering in 1941. He spent 4½ years with Monsanto Chemical Co. and 5 years with Distillation Products Industries as design engineer. For the past 10 years, he has worked with Eastman Kodak Co. as project engineer in the Engineering Div., with incursions into the design and process areas. Feichtinger is a registered P.E. in New York State and is a member of AIChE.



Recommended Safe Practices for Design of . . .

Acetylene Transmission Systems

EDITORIAL STAFF

Burgeoning demand for acetylene as a raw material in chemical synthesis has stimulated the rapid development of transmission networks.

The low-pressure system traced above, and continued on the following pages, is typical of those that may be found in Calvert City, Ky., Niagara Falls, N. Y., Montague, Mich., and along the Houston Ship Channel, as well as in other locations. On p. 134 you'll find a list of some of the chemical acetylene transmission systems in the U. S. and Canada.

Note that the most general source is calcium carbide (a coal chemical). Several locations use natural gas and in one instance acetylene is generated from refinery off-gas.

Need for a Guide

Large-scale use of acetylene for production of chemicals has created a need for a guide to the safe handling of this raw material in transmission piping systems.

Such a guide will be of great value to process design engineers, economic evaluation engineers, operation and maintenance engineers and to those chemical engineers in plant management.

Recognizing this need, the Scope of Activities Committee of the International Acetylene Assn. established several years ago a Chemical Acetylene Transmission Committee composed of members having considerable experience in this field.

The committee has recently issued its report which represents the minimum recommendations for safe operation. By special arrangement, *Chemical Engineering* outlines in this article the highlights of the report. Copies of the complete guide will be available for sale by contacting the International Acetylene Assn., 270 Park Avenue, New York 17.

Those Peculiar Properties

Primary consideration is given in the guide to those properties peculiar to acetylene and requiring special handling techniques and protective measures. For background in this subject, we refer the reader to "How to Design a Hazard-Free System to Handle Acetylene," *Chem. Eng.*, Feb. 1957, pp. 250-254.

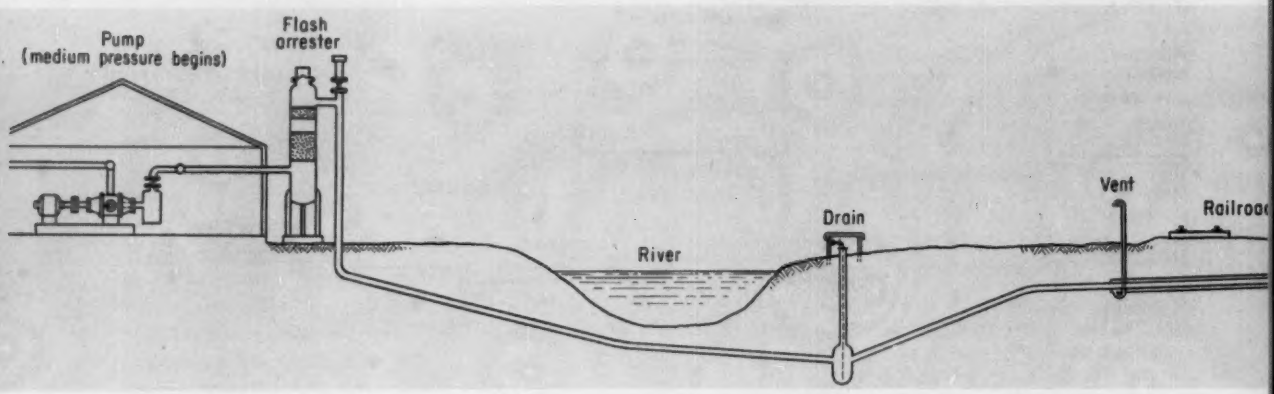
In addition to those special techniques required by the unstable nature of acetylene, construction and operation of a safe transmission system call for the observation of design precautions that apply to handling flammable gases.

The guide confines itself to safety aspects of transmitting acetylene between the source of production and the use point. When the pressure at the source is less than 1 psig., distance of transmission to the use point may make it necessary to increase the pressure with the aid of a booster system, such as the pump in the flowsheet above.

When acetylene is produced at medium pressure (1 to 15 psig.), the gasholder and the booster system would probably be eliminated.

Higher pressures are discussed in some instances. However, production and use facilities have problems of their own and are outside the scope of this guide. Also, acetylene cylinder-filling plants are not considered.

Acetylene is assumed to be of commercial quality, containing small amounts of impurities nor-



mally present when produced from calcium carbide and hydrocarbon processes. Handling mixtures of acetylene with diluents is not included.

By issuing this guide, the International Acetylene Assn. and its members make no guarantee of results and assume no liability in connection with the information or safety suggestion contained therein. It should not be assumed that every acceptable safety procedure is included, or that unusual circumstances may not require additional precautions.

Also, these recommendations should not be confused with state, municipal or insurance requirements that may apply.

Some General Rules

Approximate explosive limits of acetylene in air are at 2.5% and 82% of acetylene by volume. Also, mixtures of 82% to 100% acetylene are flammable under certain conditions.

In all cases, copper, silver, mercury and alloys or solders containing these metals should be excluded from contact with acetylene in transmission and control systems.

All piping and equipment should be grounded and bonded electrically. Resistance to ground should not exceed 1 ohm and should be checked annually. In locations subject to freezing, when the gas is water saturated, cold-weather protection is recommended for all vessel parts, valves and piping subject to accumulation of water.

Design and installation of piping systems should provide protection from localized overheating to temperatures above those encountered from atmospheric exposure.

Periodic patrolling of the system should be made a part of the operating procedure, with particular attention to corrosion, leaks, liquid drains and abnormal conditions. Lubrication and cleaning should be on a routine schedule established through operating experience. Protective devices should be tested, inspected and replaced at intervals calculated to guard against fatigue or corrosion.

Proximity Safeguards

Main acetylene transmission lines should not be run closer than 50 ft. to buildings, fire-protection reservoirs and storage tanks that contain hazardous or flammable liquids.

Increased clearances should be provided at locations that are considered to be fire or explosion hazards. Avoid installing acetylene lines in the midst of other lines which may require maintenance in which high-temperature or heavy equipment is involved.

When the transmission line comes to a road or railroad crossing, the design should be consistent with locality and layout. Either overhead or underground crossings may be used.

In underground crossings, consider the minimum entrance and exit distances from edges of the crossing, depth of fill over sleeve, location of sleeve vents and type of seal for the sleeve.

Draining and Purging

Provisions should be made to drain accumulated liquid from the transmission line. Special provisions should be made in the design to prevent entry of air into the line and to prevent freezing of any seal liquid used.

Some way of purging all acetylene lines with inert gas must be provided. Permanent purging lines may be connected to the transmission line, but the connection should be made through two valves in series and a small bleed valve.

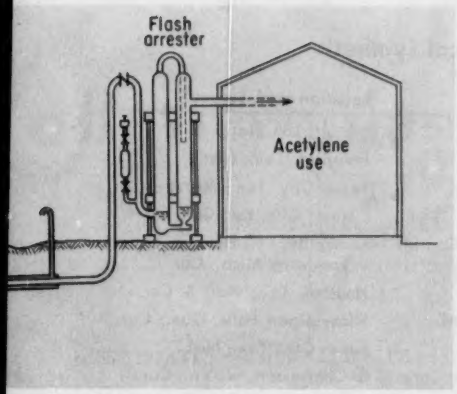
Purge systems should be protected against backflow from acetylene lines. There should be no dead-end sections in the acetylene line that cannot be purged positively. All purge connections should be designed to avoid pulling air into the system, located to prevent accumulation of condensate and designed to prevent an accidental connection of any system other than purge gas.

Piping Specifications

Piping materials of construction should meet the latest requirements of the ASA, ASTM, ASME, API or other recognized organizations. Design pressure should be that which could be developed by a decomposition of acetylene in the line.

Physical and chemical requirements and tests equal to ASTM specification A-53, A-106 or A-120 should be met in selecting the type, grade and schedule of pipe used in the system.

Up to and including 6-in., ASTM A-120, Schedule 40 welded pipes have been found to be satisfactory by repeated detonation tests in a medium-pressure system. For 8-, 10- and 12-in. pipe, ASTM A-106, Grade B, Schedule 60 pipe can be



specifically recommended on the basis of satisfactory performance in detonation tests in a medium-pressure system.

Pipe Fittings and Flanges

Screwed fittings may be used up to and including 3-in. pipe. Banded malleable iron fittings meeting ASTM A-197 are satisfactory. Cast-iron fittings and semi-steels should be excluded wherever possible.

Where nipples, couplings and half-couplings are used for attachments, they should be Schedule 80 and designed for 3,000 psi.

Cast-steel flanged fittings or forged-steel welding fittings may be used in all pipe sizes. ASTM A-234 and A-181 are recommended for forged welding fittings and flanges; ASTM A-216, Grade WCB for cast-steel flanged fittings.

Flanged, 150-lb., 6-in., cast-steel fittings with raised faces of ASTM A-216, Grade WCB, successfully passed detonation tests in a medium-pressure system. Similar tests were also satisfactorily conducted on 150-lb., 6-in. and 300-lb., 12-in. flanged welding neck and slip-on flanges with raised faces, ASTM A-181.

Blind flanges fabricated from welding neck or slip-on flanges as specified above were found to be satisfactory in detonation tests on a 6-in. pipeline.

Valves, Packing and Gaskets

Flanged or welding-neck valves are generally recommended for lines over 2-in. in diameter. Conventional plug, gate and globe valves may be used. Strength of valves should be consistent with other components in the system.

Conventional packing and lubricants for hydrocarbon gas service are recommended. Packing and lubricants should be free of copper or traces of copper.

For joining the valves to the system, alloy studs that meet ASTM A-193, Grades B6 and B7, with ASTM A-194, Class 2H heavy hex nuts have proven satisfactory in detonation tests. They are recommended for medium-pressure service. Bolts and nuts that comply with ASTM A-307 are commonly used for low-pressure service.

Gaskets made of red rubber or compressed asbestos can be used. Asbestos composition ring gaskets, $\frac{1}{16}$-in. thick have performed well in medium-pressure detonation tests.

Don't Use Expansion Joints

Use of expansion joints is not recommended.

The necessity for their use should be avoided during layout and piping design of the system. Where the use of a slip-joint cannot be avoided, proper protection against freezing and corrosion should be provided.

Suitable designs are illustrated in the full committee report.

Centrifugal, liquid-sealed compressors have been used successfully and extensively to boost the pressure in an acetylene system. Water is the common seal liquid. Whenever dry acetylene is required, another seal liquid which is compatible with the process can be substituted.

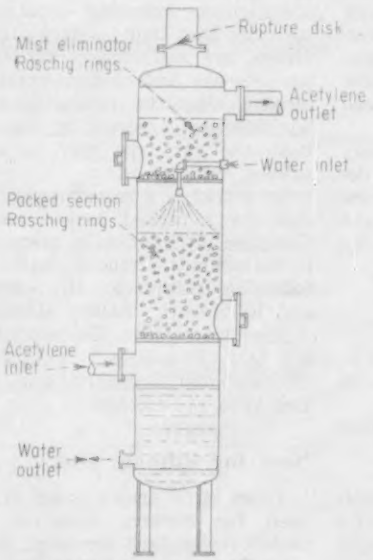
The booster system should be protected by adequate controls against the possibility of air entering the suction side, or of the discharge pressure exceeding 120% of the normal value.

A pressure-actuated switch should be considered for the discharge line downstream of the flash arrester. It should be so adjusted that it stops all booster drives in the event of excessive loss in line pressure such as might be caused by an open emergency vent, a blown rupture disk or a break in the transmission line.

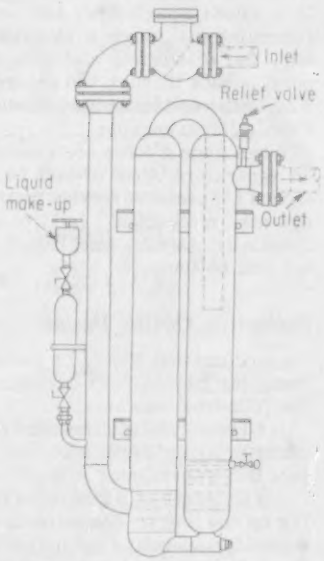
Coolers and Separators

It's best to use a gas temperature not to exceed 120 F. at the discharge of the booster system in order to minimize problems associated with excessive water condensation through the subsequent piping. Either fin-tube or shell-and-tube coolers are usually used for this service.

Two Protective Devices for Safeguarding Acetylene Systems

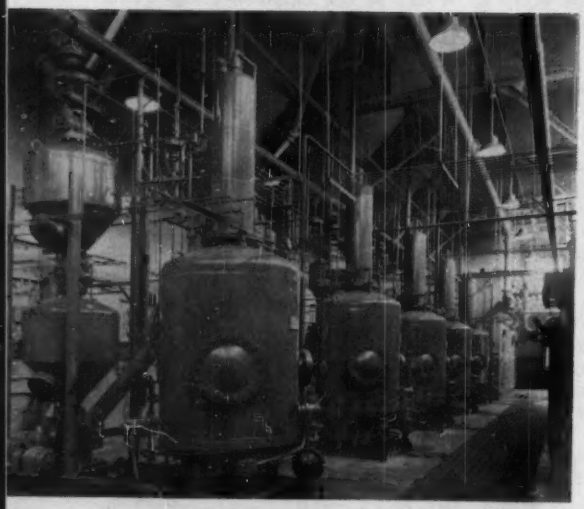


Packed Tower Flash Arrester



Hydraulic Back-Pressure Valve

Some Locations Where Acetylene Is Transmitted for Chemical Synthesis



Company	Location and Source*
American Cyanamid Co.	Fortier, La.; Nat.
Dow Chemical Co.	Freeport, Tex.; Nat.
Monsanto Chemical Co.	Texas City, Tex.; Nat.
National Carbide Co.	Calvert City, Ky.; Car.
Division of Air Reduction Co., Inc.	Louisville, Ky.; Car. Wyandotte, Mich.; Car.
Rohm & Haas	Houston, Tex.; Nat. & Car.
Shawinigan Chemicals, Ltd.	Shawinigan Falls, Que.; Car.
Union Carbide Olefins Co.	Texas City, Tex.; Nat.
Division of Union Carbide Corp.	S. Charleston, W. Va.; Car. Ashtabula, Ohio; Car. Montague, Mich.; Car. Niagara Falls, N. Y.; Car. Moundsville, W. Va.; Car. Seadrift, Tex.; Nat. Whiting, Ind.; Car. Torrance, Calif.; Ref. Memphis, Tenn.; Car.

* Source—Car. = calcium carbide; Nat. = natural gas; Ref. = refinery off-gas.

The centrifugal, liquid-seal compressor usually incorporates its own liquid separator. Line coolers, when necessary, should also incorporate a condensate trap or separatory in order to remove excess condensate.

Liquid drained from separators carries with it dissolved and entrained acetylene. If the seal liquid is a once-through-flow, not being recirculated through a closed system, the economical and safe disposal is back through the generator wherever acetylene is produced from calcium carbide.

When gage glasses are necessary on separators, they should be designed for pressure service, guarded against mechanical failure and fitted with stainless steel ball checks top and bottom.

Protective Device Design

Consideration should be given to installing packed flash arresters at the following locations:

- Terminus of the acetylene manufacturing area, acetylene enters the transmission system.
- Entrance of a gasholder floating on the line, or downstream of a gasholder operating with through-flow of gas.
- Exit of a pressure booster.
- Entrance of each consuming plant.

Function of the packed-tower flash arrester is to stop the propagation of deflagrations or detonations in transmission lines in either direction and to prevent the propagation of such explosions into plant equipment.

American operating experience indicates that liquid-wetted-packed towers are satisfactory for both low-pressure and medium-pressure service. When the installation of a liquid-wetted arrester is impractical, the dry type may be considered.

On p. 133 is a recommended design for a packed flash arrester. Complete design details are given in the committee report, and in the following reference: H. Schmidt and K. Haberl, "Safety Measures Against Acetylene Decomposition at Low Pressures," *Technische Uberwachung, Zeitschrift des TUV*, Dec. 1955, pp. 425-429.

Need for Rupture Disks

There is no known proof of the need for rupture disks at the packed-tower flash arrester. However, the practice is to install a rupture disk in the line adjacent to the arrester vessel when the line is longer than the predetonation distance.

Note, though, that rupture disks should not be used in piping systems which have a hydraulic back-pressure valve such as that shown on p. 133. Here, sudden venting would cause the loss of liquid in the hydraulic valve.

The function of hydraulic back-pressure valves is to stop the propagation of deflagrations and detonations in the acetylene transmission line. Most designs are intended for medium-pressure service since it is the most common.

Complete design details of these values are given in the full report. For design information on other parts of the system, and valuable background material, the full report should be consulted.

ACKNOWLEDGEMENTS

Chemical Engineering wishes to express its thanks to L. G. Matthews, of the International Acetylene Assn. and to Wayne Y. Scofield of Air Reduction Co., chairman of the chemical acetylene transmission committee. Also, to Union Carbide Olefins Co. for the photograph on this page.

Mr. Scofield wishes to acknowledge the assistance of the members of his committee: Donald G. Demianiw; Walter B. Howard; Warren N. Milks and W. G. Schepman.

Review Mass Transfer Concepts

Evaluation of a suitable potential difference for the driving force in mass transfer permits rational analysis of the equilibrium conditions.

JESSE COATES and BERNARD S. PRESSBURG, Louisiana State University, Baton Rouge, La.

Mass transfer and equilibrium occur in many different processes such as absorption, drying, dehumidification and distillation. In many cases, mass transfer processes are accompanied not only by the transfer of material but also the simultaneous transfer of heat.

In the present article and a number of those to follow, we will be concerned with mass transfer only, without the complicating factor of simultaneous heat transfer. This means that processes such as distillation, which is a mass transfer process in the strict sense of the word, will not be discussed, but will be handled separately because of the simultaneous heat transfer which occurs.

Mass transfer processes can be divided into a number of different categories, in accordance with the direction of flow of the solute and the nature of the phases between which transfer is taking place. Usually one of these phases has a lower density than the other and this is referred to as the light phase. The accompanying table shows one system of classification.

Mass transfer is characterized by the motion of matter through phases, under the influence of intensive forces other than strictly mechanical. One of the objectives of our article will be to point out what these forces are. We hope to show how they are related to the rate of mass transfer and to show the logical scheme for the selection of a potential difference that is useful in the calculation of mass transfer processes.

We have named a number of mass transfer processes such as absorption and stripping that, although apparently quite different, all follow the same basic equation. Like other unit operations, the rate of all mass transfer processes can be expressed by the equation:

$$\text{Rate} = \frac{\text{Potential difference}}{\text{Resistance}}$$

It will be our task to define a useful potential difference and to show means by which the resistance to mass transfer may be evaluated.

How Mass Transfer Occurs

Mass transfer may occur due to the motion of a single species through a single homogeneous phase or the

Classify Mass Transfer Operations

Process	Light Phase	Heavy Phase	Direction of Transfer
Gas absorption	Gas	Liquid	Gas to liquid
Stripping	Gas	Liquid	Liquid to gas
Liquid extraction	Light liquid	Heavy liquid	Heavy to light Light to heavy
Leaching	Liquid	Solid or slurry	Solid to liquid
Air-water contacting	Air	Water	Either direction
Drying	Gas	Solid	Solid to gas
Adsorption	Gas or liquid	Solid	Light to heavy phase

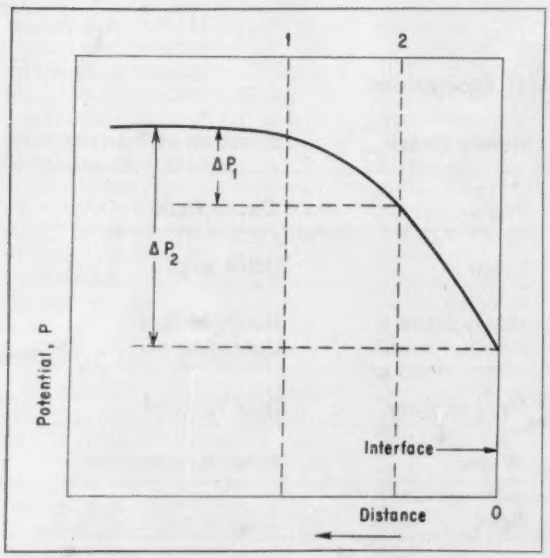
transfer of material between phases. The chemical engineer is most often concerned with those processes in which the transfer of material between phases occurs. To properly understand these processes, it is necessary to consider transfer of material within a single homogeneous phase such as transfer of a gaseous molecule through a homogeneous gas phase.

First, let us examine some of the mechanisms by means of which such transfer takes place. Consider Fig. 1 in which molecules of species A are moving through a homogeneous phase from position 1 to position 2 as shown on the diagram. The motion of these molecules can occur by:

1. Molecular diffusion.
2. Eddy diffusion or by the transport of molecules due to the existence of eddy currents.
3. Presence of some external system that is consuming species A as it arrives at its destination.

In most cases, all three of these effects are present. One of our tasks will be to separate these effects and to evaluate their relative magnitudes. The potential difference causing mass transfer by each of these mechanisms is not necessarily the same. However, we will show that by suitable mathematical relationships, the same type of potential difference can be employed in the mathematical treatment of each of these mechanisms.

Having found a suitable potential difference that can be used with satisfactory results for each of these processes, our next task will be to define and delineate the resistance to transfer that is associated with each of these mechanisms. Using the potential difference and the resistance to transfer, it should be possible to evaluate the resistance numerically. From this numerical value of resistance and our basic rate equation, we can get the rate of transfer.



TRANSFER of material toward an interface between phases requires existence of a driving potential—Fig. 1.

Define Potential Difference

Let us first consider what should be used for potential difference. At the present time, we will discuss this qualitatively and then proceed to a quantitative discussion. It has been proposed by some that fugacity or rather the difference in fugacity of the component at position 1 and that of the same component at position 2 should be a logical potential difference. It is said that fugacity sometimes called "escaping tendency," is a measure of the tendency of matter to leave its present surroundings and to enter new ones. Hence, fugacity has been suggested as a reasonable potential difference of mass transfer.

Fugacity does not adequately explain mass transfer by eddy diffusion nor does it explain mass transfer due to the presence of external forces that consume the species being transferred. It is possible, however, to use the same type of potential difference for each of the above mentioned processes. Consequently, let us focus our attention upon the possibility of using fugacity as potential difference and see if we can devise some convenient means for evaluating this term.

Eq. (1), which is a thermodynamic equation relating the fugacity change to the free energy change in any process, defines fugacity:

$$dG = RT\, d(\ln f) \tag{1}$$

When we integrate Eq. (1), the relationship between free energy of a component and its fugacity is obtained:

$$G = RT \ln f + \text{constant} \tag{2}$$

where G is free energy, R is gas constant, T is absolute temperature and f is fugacity.

As is well known, free energy is sometimes looked upon as being a chemical potential or certainly related thereto. This is why fugacity is suggested as a reasonable basis for expressing the potential difference in mass transfer processes.

Let us see how fugacity might be evaluated. Its evaluation will differ somewhat for the gas or liquid phase. Although the numerical value of fugacity is somewhat different, the starting relationship is the same. Consequently, let us look at some general equations relating fugacity to concentration and then see how these may be modified to apply to the liquid and gas phases.

Fugacity Expresses Potential Difference

Eq. (3) relates the fugacity of the component f_1 in the mixture to its activity coefficient γ_1, mole fraction N_1 and the fugacity of the component at some arbitrarily chosen standard state f_1°. In Eq. (3), the subscript refers to component one; similar subscripts will be used for other components. For our purposes, a suitable standard state is the pure component at the actual temperature and pressure existing in the mixture:

$$f_1 = \gamma_1 N_1 f_1^\circ \tag{3}$$

For gases, the fugacity in the standard state would be taken as that of the pure component in the gaseous state, at the existing total pressure and temperature. It is possible that this may prove to be a hypothetical standard state because the pure component may not actually exist as a gas under these conditions. But this

need not deter us from using this standard state, provided we are consistent in its use. Similarly, for a liquid, the standard state could be taken as the pure component as a liquid at the existing temperature and total pressure.

For gaseous mixtures, the activity coefficient γ may be taken as equal to one for all practical purposes. This is the same as assuming the gaseous state is an ideal solution. It is perfectly true that as we approach the critical pressure the gaseous state approaches the behavior of the liquid state. Hence, the assumption of ideal behavior in the gaseous state in this region is not justified.

In this article, we will confine ourselves to pressures and temperatures that are far enough removed from the critical temperature and pressure so that the activity coefficient for the component in the gaseous state may be taken as unity. We will designate the component in the gaseous state by the subscript V. With this convention, the fugacity of a component in the gaseous state is:

$$(f_V)_1 = y_1 (f_V^\circ)_1 \tag{4}$$

In Eq. (4), the fugacity of a component in the gaseous state is equal to the fugacity of the pure component as a gas at the existing temperature and total pressure multiplied by mole fraction. Adopting common usage, mole fraction of a component in the gaseous state has been designated as y. The fugacity of the pure component as a gas at the existing temperature and total pressure P may be evaluated from the equation:

$$(f_V^\circ)_1 = (\nu_P)_1 P \tag{5}$$

where ν is fugacity coefficient.

Thus, it is possible to relate the fugacity of the component in the gaseous state to the fugacity coefficient, total pressure and mole fraction. At low pressures, the fugacity coefficient is equal to one. Consequently, the fugacity of a gaseous component at low pressures is equal to the total pressure times the mole fraction. In turn, this is equal to the partial pressure. Hence, at low pressures:

$$(f_V)_1 = y_1 P = p_1 \tag{6}$$

In most applications of mass transfer relationships, it is sufficiently accurate to employ this simplification and we will do so in this series because the partial pressure and its role in mass transfer is more easily visualized than is that of fugacity. However, under conditions where this simplification is not applicable, it would be possible to modify any of the succeeding equations by substituting for partial pressure the product of the fugacity coefficient, total pressure and mole fraction.

Further, it will probably be more convenient instead of using partial pressure directly as such to use a product of total pressure and mole fraction of the vapor phase. Thus, the fugacity of a component in the vapor phase is related to mole fraction. If the fugacity difference is accepted as a reasonable potential difference in mass transfer, then it follows that the total pressure times the concentration difference, expressed as mole fraction in the gas phase, is also a satisfactory potential difference.

$$d(f_V)_1 = P(dy_1) \tag{7}$$

Apply Fugacity to Liquid Phase

For the liquid phase, the fugacity of a component is:

$$(f_L)_1 = \gamma_1 x_1 (f_L^\circ)_1 \tag{8}$$

To designate the liquid phase, we use the subscript L and to represent the mole fraction of a component in the liquid phase, x. The fugacity of the pure component as a liquid at the existing temperature and total pressure is given by:

$$(f_L^\circ)_1 = \nu_{P1}^* P_1^* e^{(V'/RT)(P-P^*)} \tag{9}$$

where

- P Total pressure.
- P_1^* Vapor pressure of the pure liquid at the temperature of the system.
- ν_{P1}^* Fugacity coefficient evaluated at P^* and T.
- V' Average molal volume of component evaluated at the average pressure between P and P^*.
- T Absolute temperature.
- R Gas constant in units consistent with those used for volume, pressure and temperature so that the exponent of e is dimensionless.
- $(f_L^\circ)_1$ Fugacity of the pure component as a liquid at the total pressure P and temperature T.

At low pressures, the term:

$$\nu_{P1}^* e^{(V'/RT)(P-P1^*)}$$

approaches unity and the fugacity of the pure component as a liquid becomes equal to the vapor pressure of the pure liquid. Hence: $(f_L^\circ)_1 = P_1^*$.

Even at moderately high pressures, the fugacity of the pure component as a liquid is substantially equal to the vapor pressure of the pure component. Consequently, in most cases it is safe to assume that the fugacity of the pure component as a liquid is equal to vapor pressure at the existing temperature. Using this relation, the fugacity for any component in the liquid phase becomes equal to:

$$f_L = \gamma x P^* \tag{10}$$

If the liquid phase were an ideal solution, then the activity coefficient γ would equal unity. For this special case, fugacity of component as a liquid is equal to the mole fraction in the liquid phase, multiplied by the vapor pressure of the pure component at the existing temperature.

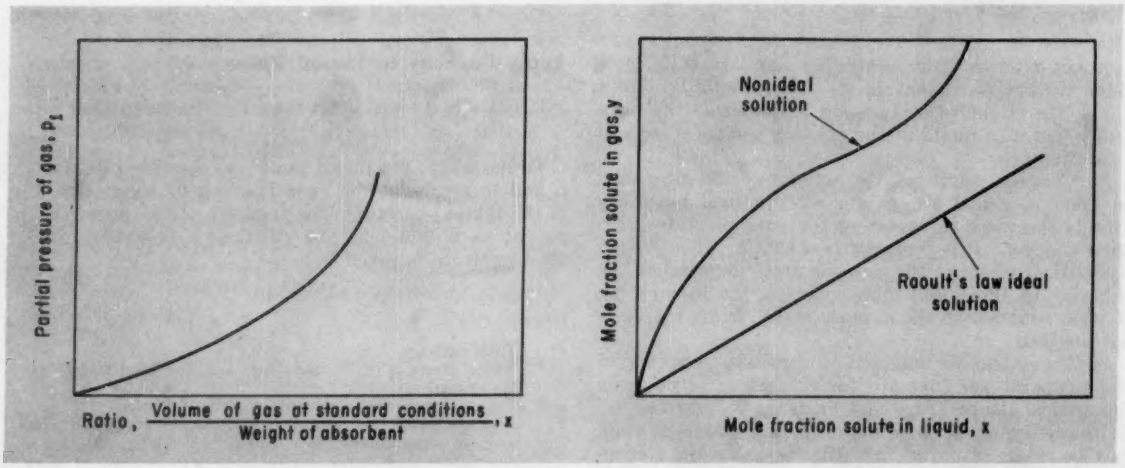
$$f_L = xP^* \tag{11}$$

We have already pointed out that, in many cases, mass transfer occurs without the complicating effect of simultaneous heat transfer. For this reason, many mass transfer processes are substantially isothermal. Hence, by using the simplification previously mentioned for the isothermal case, the change in the fugacity as a liquid is proportional to the change in the mole fraction in the liquid phase.

$$d(f_L)_1 = P_1^* (dx)_1 \tag{12}$$

If we accept the fugacity as being a reasonable potential difference for mass transfer in the liquid phase, we again have a situation in which this potential difference may be expressed as a change in concentration rather than fugacity. The change in concentration is much easier to work with than is a change in fugacity and we will adopt this technique in this series.

Thus, if the fugacity is to be used as the potential difference, we may express this in terms of the change in concentration of the gas phase multiplied by the total pressure; or the analogous relationship for the liquid phase multiplied by the vapor pressure of the


Partial pressure of gas, p_i
Ratio, Volume of gas at standard conditions / Weight of absorbent, x
Nonideal solution
Raoult's law ideal solution
Mole fraction solute in gas, y
Mole fraction solute in liquid, x

GAS-LIQUID equilibrium relations can be conveniently shown in graphical form in terms of partial pressure of gas (left) or mole fractions of components (right)—Fig. 2.

pure component. For the reasons just stated, we have adopted and will use concentration differences as the potential difference of mass transfer. As we will see later, this has other advantages when we try to relate the various potentials required for mass transfer on a common basis.

Mass Transfer Between Phases

We have seen how concentration may be used as a potential difference for mass transfer within a single phase. We have also noted that the solute may be consumed by an external system that might be another phase. This leads us to a consideration of the transfer of material between phases. The conditions at the boundary or interface between phases will be designated by the subscript i. It follows that the previous equations can be expressed in terms of the potential difference existing between any point in a phase and the interface. For example, for mass transfer in the gas phase:

$$\text{Potential difference} = (y - y_i) \qquad (13)$$

while for the liquid phase:

$$\text{Potential difference} = (x - x_i) \qquad (14)$$

Eqs. (13) and (14) are written for the situation in which mass is being transferred toward the interface. If the transfer process were taking place in the opposite direction, the terms would be reversed.

In order for material to be transferred between phases, it must first be transferred to the interface. If the potential difference remains constant, then a steady flow of material at a given point exists. If the potential difference varies with time, then an unsteady flow exists with the rate changing with time. Of course, if the potential difference becomes zero, the rate is also zero regardless of the resistance.

In batch or stagewise processes, we have continuously changing potential difference and, given sufficient time, the potential difference will reach zero and mass transfer will cease. This leads to the concept of a theoretical contact. For the moment, we can visualize a theoretical contact as being one in which the potential difference for mass transfer in a given phase has a certain finite value when the phase enters the point and this potential difference is reduced to zero when the material leaves.

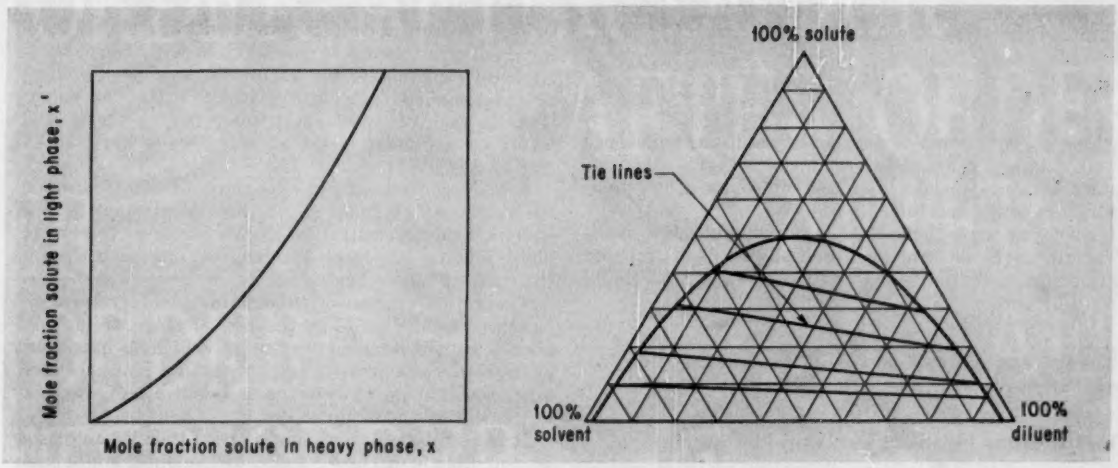
Thus, in a theoretical contact, there is a certain maximum change in concentration that can occur. This change occurs when y becomes equal to y_i for mass transfer in a gas or x becomes equal to x_i for mass transfer in a liquid. Similar expressions can be written for other types of transfer.

When mass is being transferred between a gas and a liquid phase, the concentrations at the interface are y_i and x_i for the gas and liquid phases, respectively. For transfer between two liquid phases, the concentrations of the solute at the interface between phases are represented by x_i' and x_i with one phase distinguished by using the primed superscript.

Since the numerical value of the interfacial concentrations affects the potential difference for mass transfer [$(y - y_i)$, $(x_i - x)$ or $(x_i' - x')$ as the case may be], it is important to be able to evaluate the interfacial concentration. Furthermore, since the transfer of material occurs across the interface between phases, a knowledge of the type of interaction that occurs between phases at the interface is necessary to relate the concentration of the solute in one phase with that in the other phase.

As a matter of fact, we have very little actual knowledge of what occurs at the interface. But experience has shown that by assuming that equilibrium exists between phases at the interface, useful working relations for design purposes or for the analysis of the performance of existing equipment can be obtained. For this reason, we will assume that equilibrium exists at this point until such time as a better method is developed for evaluating interfacial concentration.

We can apply the previously developed equations at equilibrium. A condition of equilibrium exists when the fugacity of each component in one phase is equal



For liquid-liquid equilibrium data, graphical results may represent solute distribution between two immiscible liquids (left) or ternary solute distribution between two partially miscible liquids (right)—Fig. 3.

to its fugacity in the other phase. For vapor-liquid equilibrium, using Eqs. (4) and (8) and setting $(f_v)_i$ equal to $(f_L)_i$, we obtain for any component:

$$y_i (f_V^o)_i = \gamma_i x_i (f_L^o)_i \quad (15)$$

At low pressures, Eq. (15) reduces to:

$$y_i P = \gamma_i x_i P_i^* = p_i \quad (16)$$

If the liquid phase is an ideal solution, then $\gamma = 1.0$ and Eq. (16) becomes:

$$y_i P = x_i P_i^* = p \quad (17)$$

Eq. (17) is the well-known Raoult's law. Note that Raoult's law holds only for ideal solutions at low pressures. For nonideal solutions, either Eq. (15) or (16) must be used. Eq. (16) can be solved for the activity coefficient.

$$\gamma_i = \frac{y_i P}{x_i P_i^*} \quad (18)$$

It is this form which is most often used to obtain γ_i from experimentally determined values of y_i, x_i P and known values of the vapor pressure of the pure component P_i^*. The relation between γ_i and the composition of the liquid x_i is best determined experimentally.

Are Available Data Limited?

However, where few data are available, it is sometimes advantageous to use an equation such as the van Laar equation, written here for the components in a binary mixture:

$$\ln \gamma_1 = \frac{AX_2^2}{[(A/B)X_1 + X_2]^2} \quad (19)$$

where the subscripts 1 and 2 designate components 1 and 2, respectively. The corresponding equation for component 2 is:

$$\ln \gamma_2 = \frac{BX_1^2}{[(B/A)X_2 + X_1]^2} \quad (20)$$

The van Laar equation or other similar equations are purported to be integrated forms of the Gibbs-Duhem equation, which is valid only at constant temperature and pressure. However, the van Laar constants A and B are usually obtained from constant pressure vapor-liquid equilibrium data in which the temperature varies. When these so-called constants are calculated from experimental data, it is found that A and B are not actually constant but vary considerably.

In spite of these drawbacks, if good average values of A and B are obtained, then the van Laar equation can be used to get a good working relation between activity coefficient and the composition of the liquid. In many mass transfer processes, such as gas absorption, the variation in temperature is small and the van Laar equations may be used with more confidence than in such processes as distillation.

Other Ways to Relate Data

Vapor-liquid equilibrium data are often expressed in terms of an equilibrium vaporization constant or "K-factor."

$$y_i/x_i = K_i \quad (21)$$

The factors which influence K can be readily seen by solving Eq. (16), which gives:

$$K_i = \frac{y_i}{x_i} = \frac{\gamma_i P_i^*}{P} \quad (22)$$

Eq. (22) shows that the equilibrium vaporization constant is a function of the temperature, pressure and composition.

Henry's law is also a very commonly used relation in vapor-liquid equilibrium computation. One of the common forms of this law is:

$$p_i = HC_i \quad (23)$$

where H is Henry's law constant and C_i is concentration of solute in liquid, moles per unit volume.

Let us look at the make-up of the Henry's law con-

stant. Combining Eqs. (23) and (16) with $C = x\,\rho_m$, we obtain:

$$H = \frac{\gamma P^*}{\rho_m} = \frac{KP}{\rho_m} \qquad (24)$$

where ρ_m equals molal density of solution, moles per unit volume. This shows that the Henry's law constant is also dependent on the composition and temperature of the solution.

Since we have agreed that we will assume equilibrium at the interface between phases, it is probably most convenient to use the relation below for gas-liquid equilibrium:

$$y_i = Kx_i \qquad (25)$$

The value of K would be obtained by the methods previously mentioned.

Equilibrium Between Two Liquid Phases

At the interface between two liquid phases, if equilibrium exists:

$$(f_L')_1 = (f_L)_1 \qquad (26)$$

where the primed quantities indicate one liquid phase and the unprimed quantities indicate the other. Using Eq. (8), we get:

$$\gamma_1' x_1' (f_L^\circ)_1 = \gamma_1 x_1 (f_L^\circ)_1$$

Since the standard state $(f_L^\circ)_1$ is the same for the component in both phases, at equilibrium:

$$\gamma_1' x_1' = \gamma_1 x_1 \qquad (27)$$

Eq. (27) is sometimes rearranged to read:

$$K_s = \frac{x'}{x} = \frac{\gamma}{\gamma'} \qquad (28)$$

Here, K_s is a coefficient showing the distribution of the component between phases. Both γ and γ' vary with the composition and again the van Laar equation or some modification of it may be used to estimate the variation of activity coefficients with composition.

Solid-Gas and Solid-Liquid Equilibrium

In these cases, we sometimes resort to semi-empirical equations such as the Freundlich equation:

$$p_1 = Bx_1^n \qquad (29)$$

where x_1 is amount of solute adsorbed per unit quantity of adsorbent, B and n are empirically determined constants. However, directly determined equilibrium concentrations are preferred and, in most cases, experimental values are used.

Rather than use equations, it is often more convenient to show the equilibrium relations in graphical form. Typical graphs for various types of processes are shown in Figs. 2 and 3.

What Is Theoretical Stage Concept?

We have already recognized that at any point in a transfer apparatus a theoretical contact might occur in which the concentration of solute in the main body of the phase becomes equal to the interfacial concentration at the point at which the phase leaves.

The idea of a theoretical contact point leads to the theoretical stage concept. It would seem at first glance that a theoretical stage should be composed of a multitude of theoretical contact points, with the phases leaving each point being in equilibrium with each other. However, to evaluate the performance of such a theoretical stage, it is necessary to know the concentrations in each phase of every component entering and leaving every point in the stage. This would be difficult to do at best.

A more convenient but less rigorous definition of a theoretical stage follows. A theoretical stage is one in which the concentration of the solute in the entire phase leaving the stage is in equilibrium with that of the solute in the other phase leaving the stage.

Theoretical stages are sometimes referred to as equilibrium stages. The theoretical stage, as defined above, is not necessarily one in which a maximum change in concentration of the entire phase occurs, since equilibrium at every point is not a necessary requirement of the definition.

It is readily apparent that a stage that is comprised of a multitude of theoretical contact points might give a greater change in concentration than the theoretical stage previously defined. Thus, the theoretical stage becomes a convenient arbitrary standard by which to express the performance of a contact device but it is not necessarily the best standard.

We should note here that the theoretical stage concept implies that sufficient time is provided in the passage of the material through the stage so that the necessary equilibrium conditions can be attained. For this reason, the resistance to transfer is not a factor. When we wish to compare the performance of actual equipment with the theoretical, then it becomes necessary to consider the rate of transfer, the resistance and time available for contact. We will return to these items in later articles.

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Pressburg has the Ph.D. from L. S. U. and holds membership in five professional societies.

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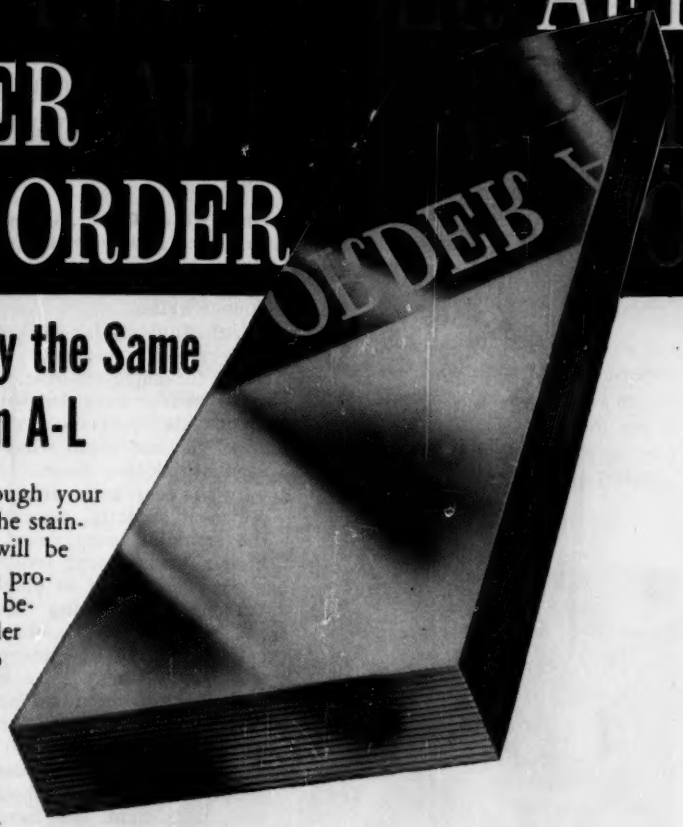

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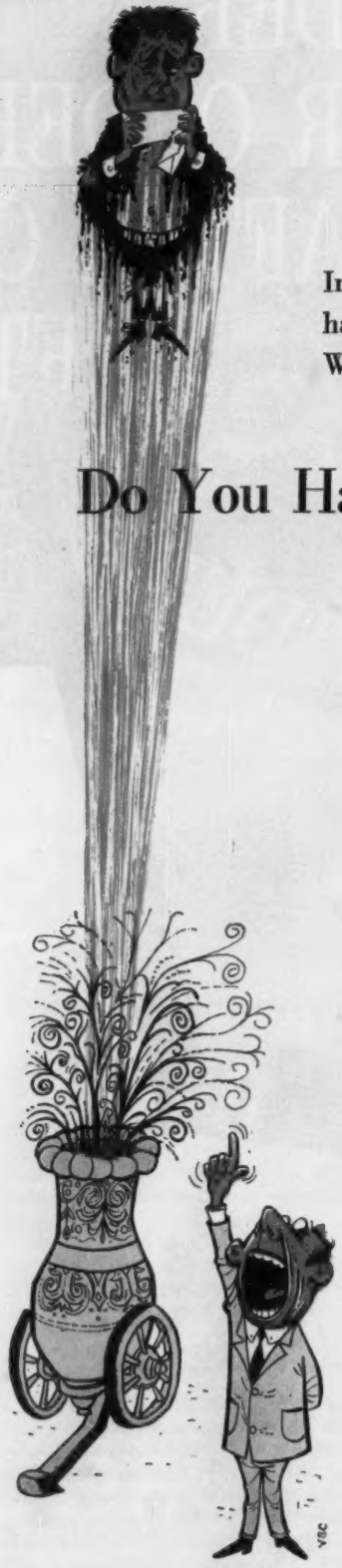

In your search for greater employment security, have you considered a "permanent employment" contract? Watch out! It may not mean what you think it means.

Do You Have a Permanent Job? Really?

Albert Woodruff Gray, Attorney, Forest Hills, N. Y.

"Words are slippery," said one famous writer.

Unfortunately for working engineers—and perhaps fortuitously for employers of engineers—our courts have decided that the words "permanent employment" do not mean what most people think they mean.

In the search for greater employment security, especially at the middle management and higher management levels, employees may seek to obtain an agreement in writing that formalizes the understanding concerning length of employment. The contract may state specifically that the individual has been hired for "permanent employment."

Although some employees have found ways to make their jobs truly permanent, most have not.

In response to a request from the editors of *Chemical Engineering*, I have looked into some of the legal precedents that may apply to written agreements between engineers and their employers covering length of employment. I think you'll be interested in what I have found.

▶ **It Never Rains**—For instance, here's a case that arose because an engineer was offered too many jobs.

A consulting engineer was offered a staff position at Purdue University in Indiana that would allow him to do consulting work at any time as long as it did not interfere with his teaching. While considering the offer, he received another one from a company in Minnesota.

The salary suggested was twice what the university could afford to pay.

After receiving a telegram from Purdue asking for an immediate decision on their offer, the engineer chose to accept the industrial position. He then wrote the following letter of acceptance:

"In accordance with our conversation yesterday when our agreement was settled regarding my position with your company, I have wired Purdue rejecting their offer.

"Under the circumstances, it was impossible for us to get together on a written agreement. However, I have made my decision based on the assumption that there will be no difficulty in working out our agreement when I get to your plant.

"Propositions like the one Purdue made are very rare, but I am turning it down since I feel that the opportunities with your

Illustration adapted from jacket design of "The Pink Slip," by Bill Longgood and Ed Wallace, McGraw-Hill Book Co., Inc., New York (1959). For an amusing and informative discussion of management's firing techniques, this book is recommended reading.

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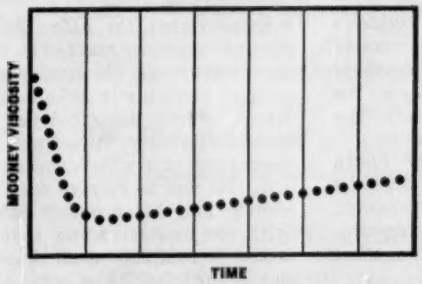

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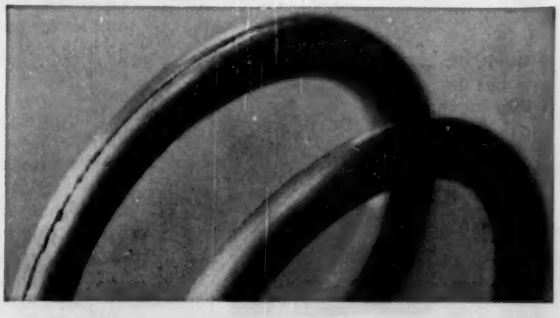

FLUOREL 2141 "O" ring, bottom. Note freedom from defects because of the improved scorch characteristics of FLUOREL Elastomer "O" ring as opposed to elastomer at top of photograph.

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company for applying my past experience are very attractive. The essential consideration, however, is that the job will be a permanent one."

▶**Axed After Two Years**—Despite the fact that he had stipulated a permanent position, after only two years of employment the engineer was fired.

Feeling greatly wronged, he brought suit for what he claimed was a breach of contract for permanent employment. When a lower court turned him down, he appealed to the supreme court of the state for justice.

The state supreme court affirmed the decision of the lower court, using this language:

"The reported cases where no other consideration than a promise to perform a service passes from the employee to the employer are almost unanimous in applying the general rule that the words *permanent, lasting, constant* or *steady,* applied to the terms of employment, do not constitute a contract of employment for life or for any definite period.

"This employee merely abandoned other activities and interests to enter into the service of this employer. Almost every desirable servant does this upon entering a new service, but this cannot be regarded as constituting any additional consideration."[1]

▶**Additional Consideration** — The phrase "additional consideration" has been the decisive issue in the few cases where a job has been ruled to be a permanent one. An additional consideration can be any sacrifice which a prospective employee makes in order to accept a job.

In the Minnesota case described above, the additional consideration was not judged to be sufficient; but in a similar case in Michigan, an employee was awarded a permanent job.

A Michigan farm management expert, who already had an established business in his home state, was induced to move with his family to South Carolina to oversee a large plantation.

Under the contract made by this man with his employer, it was provided that he would be discharged only if he failed to perform properly his duties and obligations under the contract. If it became necessary to discharge him, he was to be given reasonable and proper notice.

Three years later, the overseer was notified that his employment was to terminate suddenly on the first of the following month. The overseer sued.

▶**Employee Wins** — The South Carolina court agreed that the employee had a valid contract, and therefore could recover damages for its breach. The court said:

"The general rule unquestionably is that under ordinary circumstances a contract to furnish employment permanently is no more than an indefinite general hiring terminable at the will of either party and is therefore unenforceable as to its duration.

"But this rule does not apply where the employee had given additional consideration in addition to the services to be rendered.

"Abandonment by the employee of his business in Michigan in order to accept the employment which was offered to him in a distant state constituted such an additional consideration as to take this case out of the general rule and to render the contract enforceable."[2]

This case was certainly exceptional and today an engineer is far more likely to be treated as when a federal court considered the case of an engineer whose job involved the molding of resistors.

▶**You're Through!**—This engineer was informed by his employer that the process he was working on would be discontinued. When he asked how the discontinuance would affect him, the engineer received the laconic answer:

"You're through!"

The case went all the way to the U. S. Court of Appeals, which said:

"This was a contract at will which could be terminated at the option of either party at any time. No time being fixed during which the agreement would remain in force, it could be terminated at the will of either party and it makes no difference that his contract was, in his own words, 'permanent.'"[3]

But cases of this kind are not always as clearly defined as the ones given above. The factor of additional consideration is often difficult to identify.

▶**Employment for Life**—A 67-year-old engineer reached an oral agreement with his employer, a utilities company in Arkansas, in which he was delegated the responsibility for directing the operations of a water-works system. He was to receive approximately half his previous salary with the understanding that he would be available at all times to act in the capacity of consulting engineer.

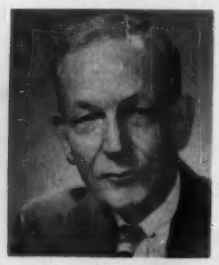
He was also advised that he might perform similar services for others as long as such work did not interfere with his duties with the utilities company.

When he was discharged five years later at the age of 72, the engineer sued. In its defense, the company contended that the contract was invalid. But it lost the case.

The federal appellate court held that in this instance there was a valid and enforceable contract, that the engineer could collect damages. It said:

"We are clear that there is nothing in this case indicating that a bilateral contract for life employment is not enforceable under the laws of Arkansas."[4]

On the other hand, an almost



ALBERT WOODRUFF GRAY was born in Middletown Springs, Vt., and attended Yale Univ. and New York Law School. He has been engaged in the independent practice of law for more than 20 years. Gray is the author of Conover-Mast's "Purchase Law Manual" and *CE*'s articles "How Our Laws Protect Engineering Ideas" (Mar. 9, 1959), "Why Engineering License Laws?" (July 13, 1959) and "You Must Deliver Competency and Skill" (Mar. 21, 1960).

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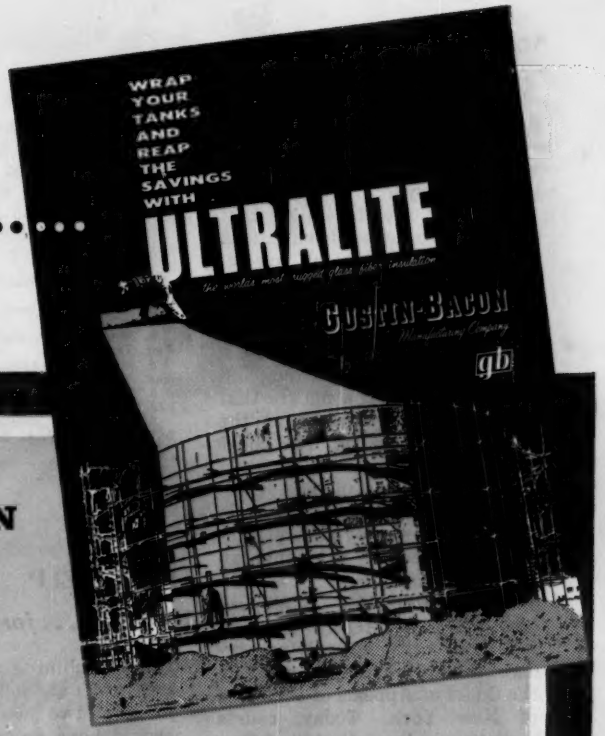

TECHNICAL BULLETIN ON INSULATING HEATED STORAGE TANKS SHOWS YOU . . .

- An easy way to figure how many btu's (and dollars) are now being wasted by your uninsulated tanks, vats and vessels.
- Latest lower-cost techniques of insulating large and small tanks.
- Why ULTRALITE, far more effectively than any other insulation, meets *all* the requirements for permanent and economical tank insulation.
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The new 8-page ULTRALITE Tank Insulation Brochure, we believe, offers the most comprehensive and current information available on the who-what-why-when-and-how of insulating tanks. Your free copy is available for the asking—just write today.

GUSTIN-BACON *Manufacturing Company* **gb**

252 West 10th St., Kansas City, Mo.

Thermal and acoustical glass fiber insulations . . . Molded glass fiber pipe insulation
Couplings and fittings for plain and grooved end pipe

identical case with an almost opposite verdict is recorded in Missouri. An offer of employment was predicated by this comment by the employer:

"At your age, I suppose that you want to settle down into a permanent thing and if you accept this position with us it would be a permanent one."

However, in spite of the language used by the employer, the court decided that the employment was of such a nature that it might be terminated at the will of either party. The court stated:

"The term 'permanent position' and kindred expressions in contracts of employment are intended to mean no more than an indefinite employment."[5]

▶ **Most General Rule**—Most general and consistently followed rule for contracts involving permanent employment was made by the Court of Appeals of the State of New York. Today, courts throughout the country follow this decision.

Suit had been brought by a shipbuilder against the Morse Dry Dock and Repair Co. for breach of what the shipbuilder understood to be a permanent employment agreement.

After the case had been drawn out through two lower courts, the final authority said:

"Whenever these words 'permanent employment' have been used in contracts which have been made between employer and employee they have been held to mean a steady employment, a steady job, a position of some importance, as contrasted with a temporary job or a temporary employment.

"Standing alone and by themselves, they do not mean life employment. An agreement to give a person permanent employment means nothing more than that the employment is to continue indefinitely and until one or another of the parties wishes for some good reason to sever the relation."[6]

▶ **Settle for Notice**—After examining the precedents in the field, and especially in view of the decision by the New York Court of Appeals, it seems that permanent employment contracts offer little real security.

It might be more advantageous to both employer and employee if written agreements are based, instead, on the concept that a designated period of notice must be given before the employment is terminated by either party.

REFERENCES

1. Skager vs. Blandin Paper Co., 266 *N. W.* 872, *Minn.*
2. Weber vs. Perry, 21 *S.E.* 2nd 193, *S. C.*
3. Meadows vs. Radio Industries, 222 *Fed.* 2nd 347, *Ill.*
4. Abbott vs. Arkansas Utilities, 165 *Fed.* 2nd 339, *Ark.*
5. Minter vs. Tootle-Campbell Co., 173 *S.W.* 4, *Mo.*
6. Arentz vs. Morse Dry Dock & Repair Co., 164, *N. E.* 342, *N. Y.*

NEW HELP

. . . *for Job Seekers*

By combining your qualifications with the helpful hints outlined in two new booklets, you should have no trouble in landing a job in the chemical process industries.

The booklets list interview tips, expense account procedures, sample data sheets, resumes, employment agencies. They are being distributed at no charge for single copies.

"Employment Pointers for Chemical Engineers" can be obtained by writing to AIChE, 25 West 45th St., New York 36, N. Y. "Finding Employment in the Chemical Profession," is available upon request from ACS, 1155 Sixteenth St., N. W., Washington 6, D. C.

PH. D. AVAILABLE

. . . *in Six-Year Course*

Exceptional students will now be able to earn an engineering doctorate in only six years from the time of enrollment as a freshman. Brooklyn Polytechnic Institute will operate the new program under a $700,000 grant from the Ford Foundation.

Approximately 6% of this fall's freshmen will be enrolled in the special curriculum at BPI, which features extra lectures, original research and seminars by visiting engineers and scientists, in addition to a core of math, physics, chemistry and the humanities.

Students will begin original research in their third year.

10,000 JOIN

. . . *Stock Option Plan*

Over 10,000 employees of Monsanto Chemical Co. have taken three-year options to buy 433,000 shares of the common stock of their employer.

Last March, Monsanto stockholders authorized sale to begin on June 3rd at a price of 95% of that day's closing quotation. The stock was sold at $39.50/share and, happily for the employees, went to 41 by the middle of July. Then the market took a turn for the worse and the end of July brought prices as low as $38/share.

In Monsanto's plan, employees may have up to 10% of their income deducted for the eventual exercise of the option. Meanwhile, the company pays 4½% interest, compounded semiannually, on money deducted which is not used to purchase stock.

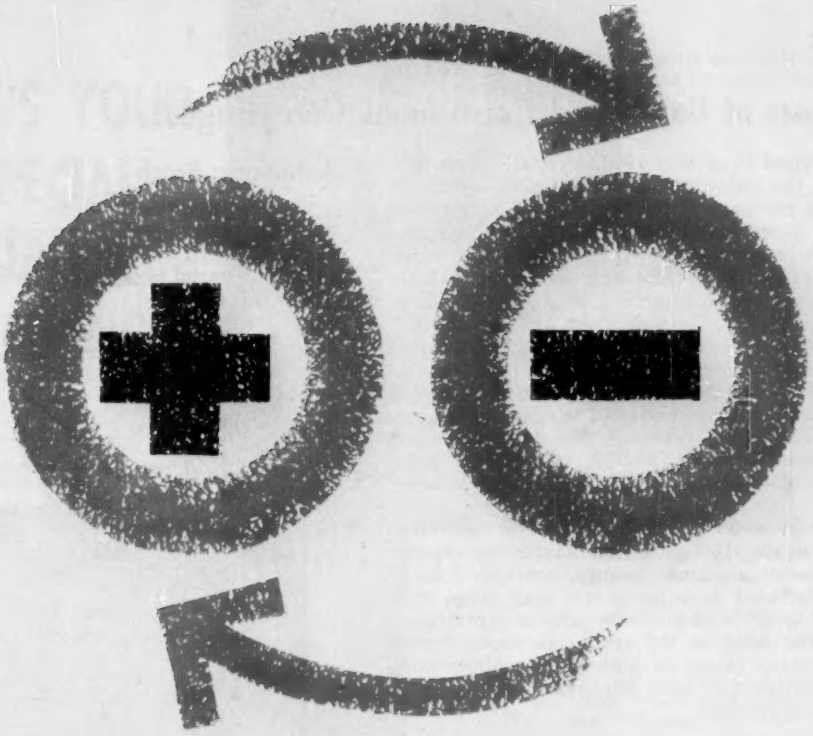
FULL EXPLANATION

. . . *of Education Expenses*

Internal Revenue Service of the U. S. Treasury Dept. in response to many requests for a better explanation of allowable income tax deductions for educational expenses has issued a bulletin of detailed rulings.

The bulletin is identified as Revenue Ruling No. 60-97 and is known as "Guides concerning the federal income tax treatment of expenses incurred by taxpayers for education."

In another recent action, IRS has now decided that fees paid to an employment agency can not, repeat not, be deducted by the employee as a cost of obtaining a new job. They may only be deducted by the employer as a business expense.



An assignment in migrating ions . . . for Lukens Application Research.

Corrosion. This is the metallurgical result of ion migration. It's a frequent opponent for the Lukens Application Engineer in his job of helping you determine the *best* steel for "problem" applications. In the case of miscellaneous-cargo tankers, for instance, corrosive hot caustics are often carried on one leg of a trip; on another... high purity glycerine that must not become contaminated. How, marine designers asked, can we get *economical* protection both for cargoes and hold tanks? Drawing on years of experience with process industries equipment, Lukens Application Research suggested the answer: nickel-clad steel—highly corrosion-resistant, comparatively inexpensive—with a special sodium hydride finish that is easy to clean, expedites conversion.

Experience and ingenuity are the stock-in-trade of Lukens Application Engineers. For personal assistance on problems of metals application—corrosion, cryogenics, metal expansivity, abrasion, structural stress—please contact us. Write Manager, Application Engineering, H-90 Services Building, Lukens Steel Company, Coatesville, Pennsylvania. Also contact us for Clad Steel Equipment Bulletin No. H-90.

HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB

CE COST FILE

No. 39: Centrifugal Separators

J. C. Smith, Cornell University, Ithaca, N. Y.

Costs of Batch and Continuous Centrifuges*

Priced as of May 1960, correlations on this and the following page give order-of-magnitude purchase prices for process centrifuges.

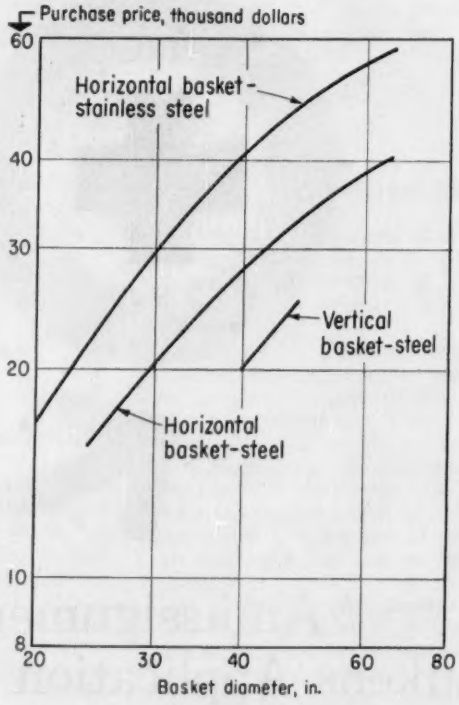
Top-suspended sedimentation centrifuges with imperforate bowls cost about 10% more than similar machines with perforated baskets. A fume hood adds about 15% to cost of a top-suspended centrifuge. An explosion-proof motor adds 15-35% to cost of machine in steel construction.

Minimum installation costs, covering simple foundation and minimum wiring and piping, are: 6-10% of purchase price for tubular and disk centrifuges; 10-25% of purchase price for bottom-driven centrifuges, automatic batch centrifugals and mechanical conveyor centrifuges; 25-30% for top-suspended batch centrifugals. If cost of all auxiliaries—special foundations, tanks, pumps, conveyors, etc.—is included, installation cost may range from 100 to 400% of purchase price of centrifuge.

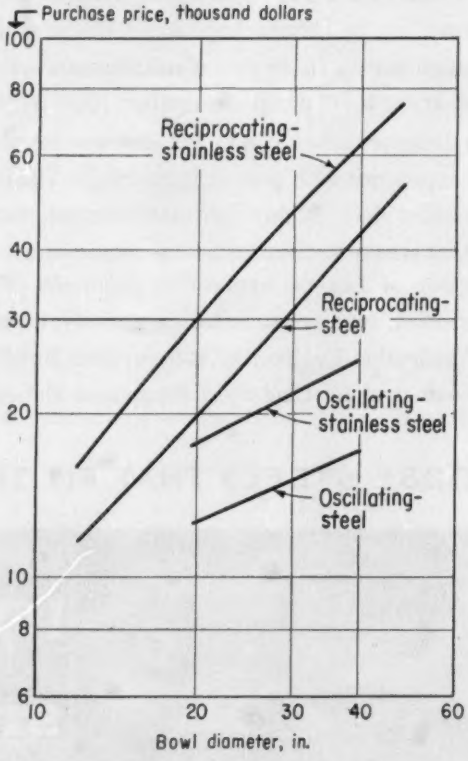
The table on the next page shows typical purchase prices of high-speed sedimentation centrifuges without mechanical conveyors for solids removal.

*Based on a manuscript prepared for the fourth edition of Perry's "Chemical Engineers' Handbook."

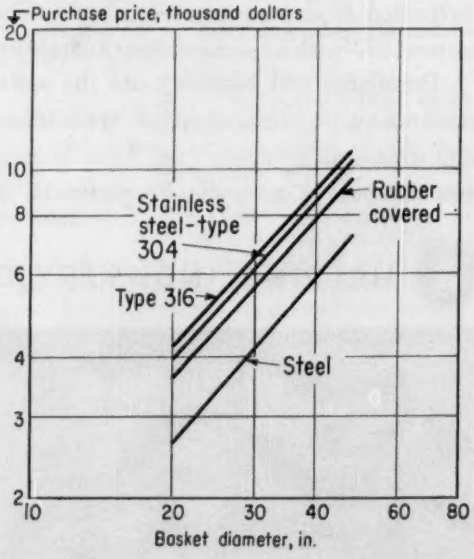
Automatic Batch



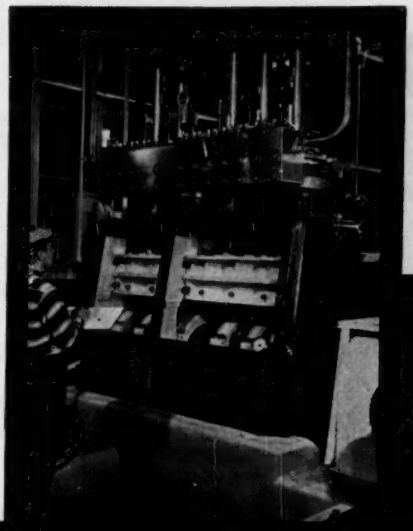
Reciprocating Conveyor & Oscillating Screen



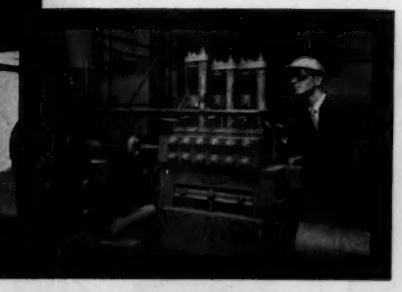
Top-Suspended Filtering



WHAT'S YOUR SPECIAL PROBLEM IN PUMPING?



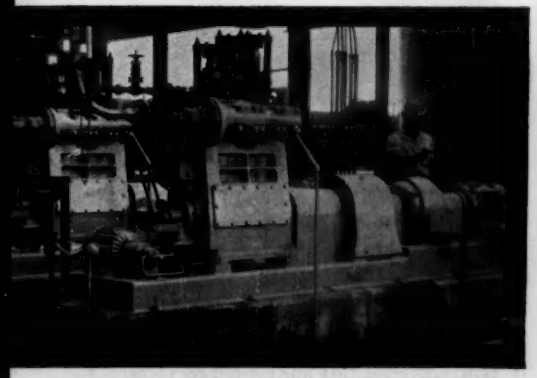
Special nylon ball valve and stainless steel fluid end handle silica gel at 1800 psi.

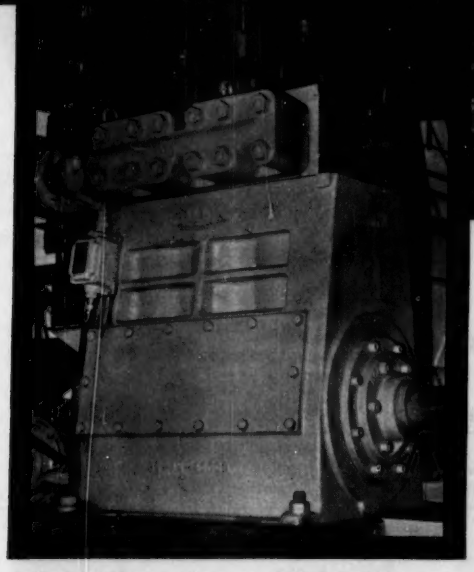


Here, Aldrich pumps continuously control the flow of liquid ammonia at 3700 psi.

This Aldrich pump handles highly corrosive chemicals—both alkaline and acidic.

Aldrich pumps with nickel alloy fluid end pump 50% caustic soda solution at 400 psi.





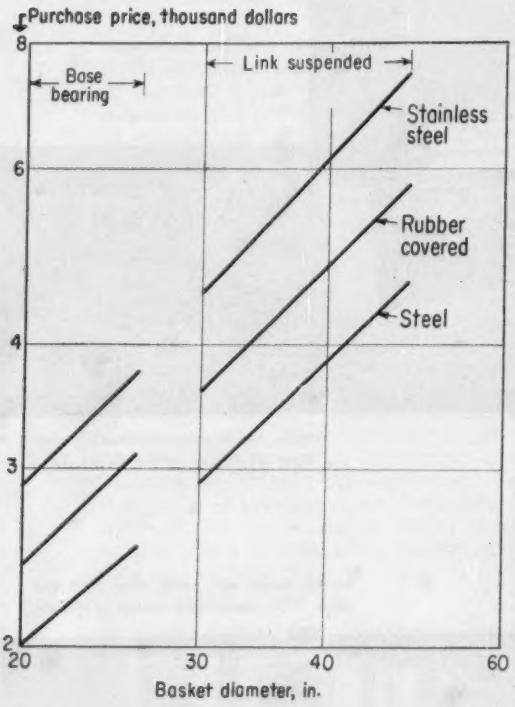
To handle, alternately, caustic and brine, at 3000 psi, this Aldrich Triplex pump has entire fluid end of Monel.

Corrosives? Slurries? High pressures? High temperatures? We'll find the answer!

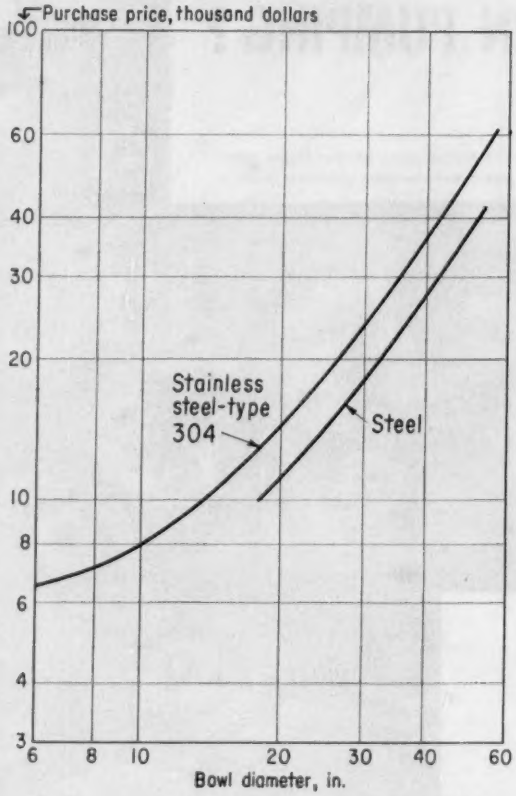
All pump companies sell pumps. And all have their share of pumping problems. At Aldrich, our most important stock in trade is our ability to solve the rough pumping problems of the process industries. We've had over 50 years of working with chemicals and chemical processes. We know the problems of pump wear; of temperature, corrosion, viscosity; and your need for sustained pump operation. We study all the factors in your problem, in depth . . . and come up with a *better* answer, not merely *an* answer. For information on capacities, pressures and sizes, see our insert in *Chemical Engineering Catalog* or write for reprint (Data Sheet 100). ALDRICH PUMP COMPANY, 3 Gordon Street, Allentown, Penna.

The tough pumping problems go to ALDRICH

Bottom-Driven



Scroll-Conveyor Sedimentation

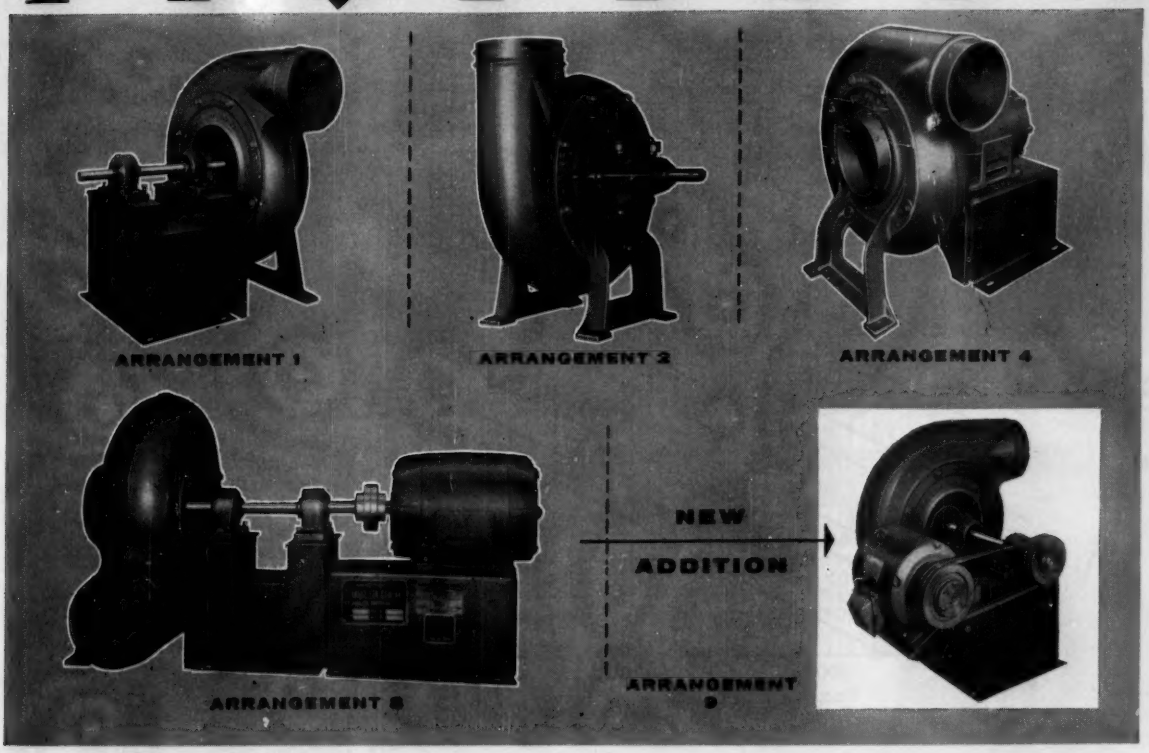


New Cost Book

Just out this past month, "Cost Engineering in the Process Industries" contains over 450 pages of articles and data culled from *Chemical Engineering*. The book, published by McGraw-Hill, was compiled and edited by C. H. Chilton.

High-Speed Sedimentation Centrifuges

Type	Bowl Dia., In.	Service	Purchase Price, $	Remarks
Tubular	4–6	Oil purifier	1,800–4,500	Steel
		Chemical separator	3,500–8,000	Stainless steel
		Lacquer clarifier	5,800	Portable
Disk	12	Oil purifier	2,000–5,000	Steel
	24	Hermetic	10,000–25,000	Stainless steel
Nozzle-discharge	12		8,000	Stainless steel
	18		16,000–25,000	
	18	Pressure operation	30,000–60,000	
Self-opening	12		8,000	Stainless steel
	18		15,000	
	24		23,000	



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Volumes to 3800 CFM, pressures to 18", temperatures to 750°F., six sizes, three wheel types, five arrangements as shown above, adjustable to any of the eight standard air discharge directions.

Result: fan equipment uniquely well suited to nearly every service imaginable. The uncomplicated, heavy construction, featuring cast iron housings and sideplates, makes the Type CI the natural selection for such severe applications as exhausting from grinding, woodworking, and other machines . . . conveying materials ranging from fibers to grains . . . removing smoke and fumes . . . furnishing industrial process air . . . handling chemical and hot gases.

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Dependable equipment for making air your servant

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SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

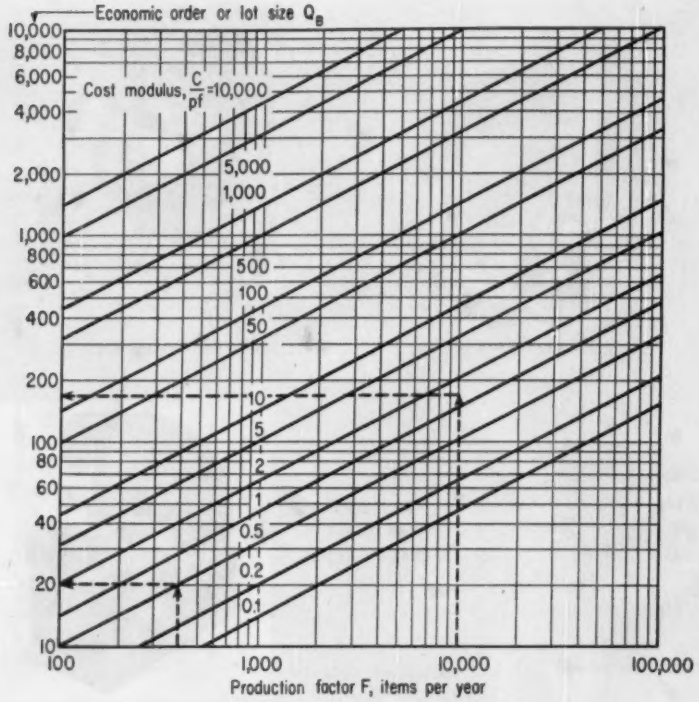


Chart Speeds Calculation Of Economic Batch Size

Knowing cost to prepare for a run, plus cost per unit of product and carrying charges applying to inventory, here's how to find economic batch size.

H. C. Schweyer
Professor of Chemical Engineering, University of Florida, Gainesville, Fla.

In many textbooks you can find an equation for determining the economic size of a batch or inventory or of a production lot, and this is always of the form of:

$$Q_s = \sqrt{2C/pf} \cdot \sqrt{F}$$

where Q_s is the economic number of units per batch or per production lot. Here C is the "setup" cost per batch, the "make-ready" cost for a production run, the cost of each order, etc. The value of a unit is p and f is the fraction of the value p that is chargeable annually to holding cost or carrying charge, due to the inventory that is being considered. This charge includes interest on the capital equivalent to the inventory, plus any warehousing or storage charges.

The term F is a production factor that varies with the type of problem. Where a strictly batch operation is involved, F is equal to Q_A, the number of units to be produced annually. Where the operation is semicontinuous, with both production and withdrawal occurring simultaneously, the value of F is $m/(m/Q_A - 1)$. Then m is the instantaneous manufacturing rate on a yearly basis, in items per year, and Q_A is the annual demand rate in items per year, which is the same as the over-all average withdrawal rate.

If we take logs of both sides of the equation above it becomes:

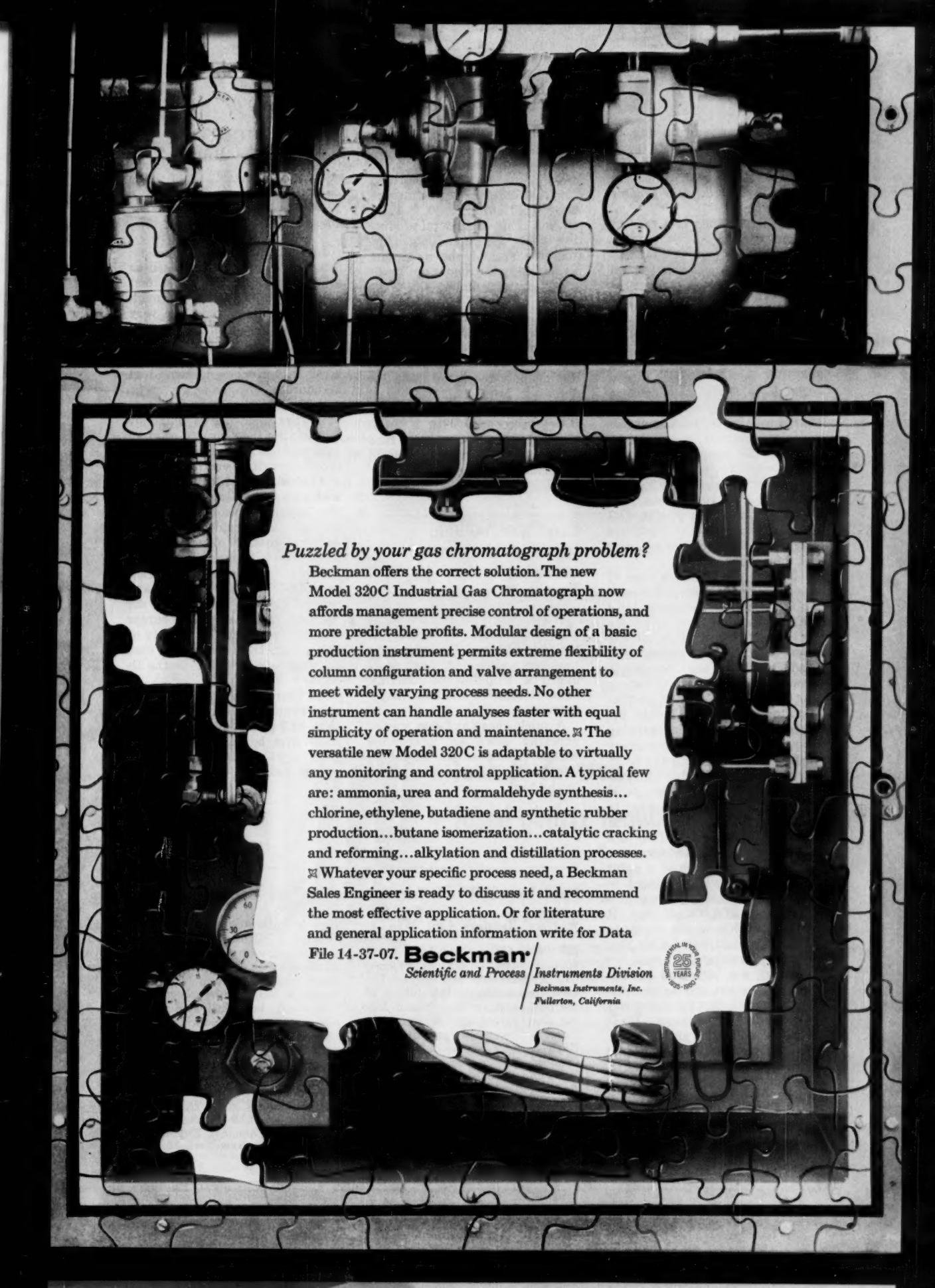
$$\log Q_s = \tfrac{1}{2} \log (2C/pf) + \tfrac{1}{2} \log F$$

which is the equation of a series of straight lines with a slope of 0.5 and with values of Q_s equal to the first term when F is unity and log F, therefore, is zero. These lines are plotted on a log-log grid as at the left and are easily plotted to large scale by following the specification just given. A chart of this type is useful for routine estimations of economic size and its use can easily be taught to nontechnical personnel. As the problems below will show, the chart is capable of covering a wide range of values, even though it may appear to be fairly limited.

To use the chart, it is only necessary to know the conditions for F and the cost modulus (C/pf) for any item, to estimate the optimum quantity to consider for each batch or lot.

Example 1—This is a case of determining the economic size of order for a small quantity. Suppose that an office uses 400 special machine book forms per year, costing \$40 each. We know that it costs \$3 to place an order and that the carrying costs for an inventory of these books is 15% of the unit value. What is the economic size of the order?

Solution—Here the cost modulus (C/pf) is $(3/40 \times 0.15) = 0.5$. The annual requirement F is 400. Entering the chart at $F = 400$ and going vertically to the cost modulus line for $(C/pf) = 0.5$, then horizontally to the Q_s scale, we find $Q_s = 20$, which means that the economic order is 20 of the machine books. If more than 20 are ordered at a time, then the total cost of ordering plus carrying will be



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larger than optimum, owing to excessive carrying cost. If fewer than 20 are ordered, then the excessive number of re-orders will make the total cost greater than optimum.

Example 2—This is a case of determining the economic order size for a large quantity, exceeding the chart range. What is the economic order size for purchasing a raw material that costs \$0.04165/lb., with carrying charges for inventory at 12%? Annual usage is 20,000,000 lb., and the cost to place an order, \$14.

Solution—On a pound basis, the annual usage exceeds the chart range, so it is necessary to convert to annual tons and cost per ton. The usage becomes 10,000 tons/year and the cost, \$83.30/ton. When the chart is used with F = 10,000 tons/year and a cost modulus of (14/83.3 × 0.12) = 1.4, the optimum batch size for purchase becomes 167 tons/order.

Example 3—This is a case of determining the economic size of a production lot. In this case, we are withdrawing from inventory for sale of the product, at the same time we are adding new production to the inventory. However, the withdrawal rate is less than the make rate, so that inventory gradually builds up. It is possible for the carrying charge on this average inventory to become excessive relative to the setup costs involved in getting ready to make a lot, so it may become more economical to make a greater number of smaller lots, which build up to a smaller average inventory.

Let's take the case of a paint manufacturer who produces in lots with an instantaneous production rate of 5,000 gal./day. It costs him \$400 to get ready to run a lot, and \$2/gal. for his production. Carrying charges on his inventory are 10% and his annual production and sales average 1,000 gal./day for 320 days/year for all calculations. What is the economic lot size?

Solution—Here m = 5,000 × 320 = 1,600,000 gal./year and Q_1 = 1,000 × 320 = 320,000 gal./year, so F = 1,600,000/(5,000/1,000 − 1) = 400,000. This will not fit the chart, so we convert to units of 1,000 g..., where m = 1,600 units and Q_1 = 320 units/year. Then F = 400 and the cost modulus becomes 400/(2 × 1,000 × 0.1) = 2. From the chart, at F = 400 and a cost modulus of 2, Q_2 = 40 units, or 40 × 1,000 gal./lot. This is the total production in any one lot and is greater than the size of the maximum inventory by the amount of product withdrawn during the make period.

This chart is useful for economic analysis and inventory applications wherever the data for the cost modulus are available. Having only the setup costs for different products, their cost per unit and the carrying charge factor, personnel with a minimum of training can easily read off optimum order or lot size in a matter of seconds.

Easy Way to Stop Discharge Vortexing

Richard D. Connolly
Danville, Pa.

When vortexing occurs in emptying a tank of liquid, air may be entrained to foul up the next processing step. Such cases might be in up-flow ion-exchange beds, distillation and flow instrumentation.

A quick, cheap and easy way of knocking down an unexpected vortex is to float an all-rubber basketball or some similar object in the tank.

Calculating Gas Flow With a Slide Rule

W. L. Scheirman
Process Supervisor
Black, Sivalls & Bryson, Inc.
Oklahoma City, Okla.

In natural gas production, flow rate is usually expressed as millions of standard cubic feet per day (MMSCFD). Through a lucky accident, there's a very easy way to convert to weight rate of flow, as shown below.

An air flow of 1 MMSCFD = 3,182 lb./hr. when measured at standard conditions of 14.7 psia. and 60 F. The weight flow rate of natural gas can be found by multiplying the weight flow of an equivalent air volume by the gas specific gravity—and here's how:

The value of $10{,}000/\pi$ = 3,183 which is almost exactly equal to the weight flow of air given above. Therefore, to convert the gas volumetric flow rate in MMSCFD to lb./hr., set the hairline of the cursor to the flow rate in MMSCFD on the DF-scale and set the index of the slide to the hairline. Then, move the cursor hairline to the specific gravity of the gas on the C-scale and read the flow rate in lb./hr. on the D-scale.

Of course, if the gas is measured at some pressure base other than 14.7 psia., the gas flow rate must first be converted to 14.7 psia. by multiplying by the actual pressure base in psia./14.7.

Next Issue: Watch for Winner of July Contest

★ How Readers Can Win

\$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award \$50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks. Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

\$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional \$100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates (\$10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.

instant and automatic relief of excess pressure with dependable corrosion-resistant rupture discs

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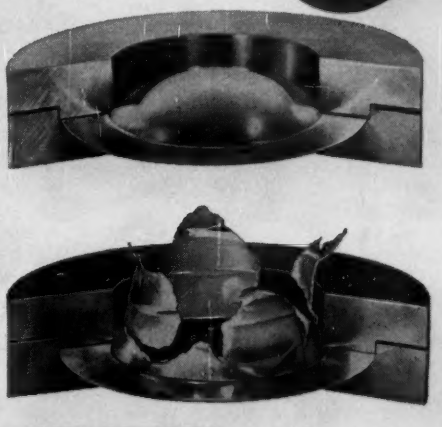

In pressurized apparatus subject to corrosive action, precious metal rupture discs provide the safest, most accurate and dependable relief. Platinum, gold, and silver are now generally recognized as specifics when dealing with corrosion. Each is resistant to the corrosive effects of an important group of liquids and gases and will remain unattacked under conditions that would render many base metal materials useless. These rupture discs, depending on material selected, are guaranteed to be burst ±5% of specified pressure. Intrinsic value adds to the original cost of these discs but the actual metal value is recovered, no matter how torn or battered the discs may be. Send for literature.

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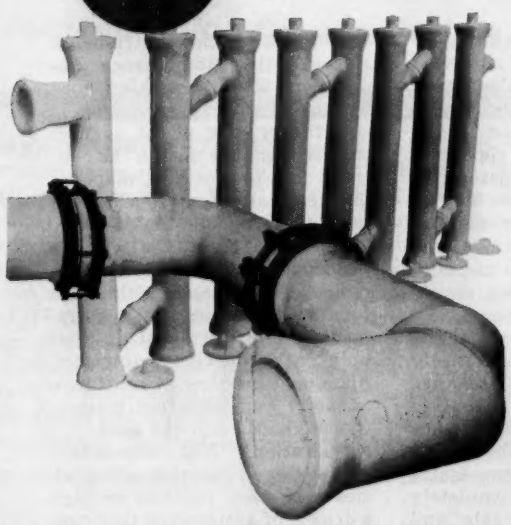

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Amersil manufactures and fabricates high purity fused quartz for ultraviolet transmission applications, laboratory ware and production equipment. These products include standard apparatus, plain tubing in many intricate fabrications, crucibles, trays, cylindrical containers and piping in a full range of sizes up to 25" in diameter. Ingots and plates are available in general commercial quality as well as in special optical grades. Amersil engineers are also prepared to assist in developing fused quartz and silica equipment for special requirements. Send for literature.

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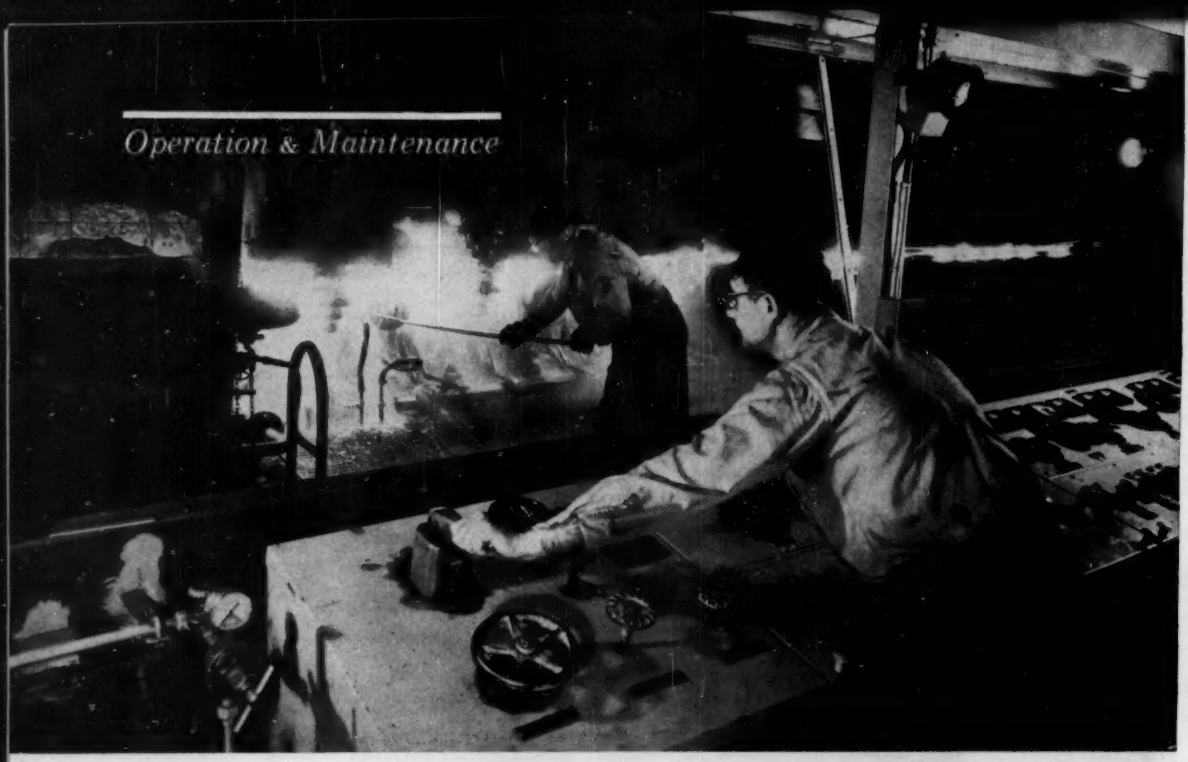

The Operating Man

From plant manager to operator, he is the backbone of the plant; his work is as often art as science.

Peter J. Brennan, Assistant Editor

No function is more important to any plant than that of Operations. Maintenance men might argue with that, but it is nonetheless true.

Operations is concerned with everything that goes on in a plant, including maintenance, accounting and personnel. All other plant departments exist only to support Operations. Often there is no Operations Department in a plant per se, it is more often known as the Production Department, and as such is responsible for efficient production of the products that the plant was designed to make.

▶Who Is in Operations?—Everyone directly concerned with production from the plant manager on down is in Operations. However, when we speak of operating personnel, we normally think of the people on the line—operators, foremen, production supervisors and engineers. These are the men who set production schedules, make equipment do things it wasn't designed for, come out in the middle of the night to cope with emergencies and determine when their departments may be shut down for major maintenance. These are the men who know how to keep a piece of equipment running that should have been scrapped long ago.

There has been some talk of completely replacing operating personnel with maintenance people, not only at the operating level but even at the supervisory level. According to the proponents of this scheme, successful plant operations are completely dependent upon adequate and well-planned maintenance. They say that, in a highly automated plant, operating people are superfluous—they have nothing to do but watch the instruments and call the Maintenance Department when something goes wrong. Therefore, according to this theory, you might as well put maintenance men in the control room in the first place so that they can attend to problems immediately. The Maintenance Department would schedule shutdowns and other maintenance in accordance with maintenance, not operating, requirements. The argument is that only a properly maintained plant can produce at maximum capacity and therefore maintenance should call the tune.

▶Operations Not Obsolete—While some refineries and utilities may have reached so high a degree of automation that continuous operation is essentially a maintenance problem, we doubt that the average chemical plant is anywhere near that

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The choice of FOAMGLAS insulation for these huge tanks was no accident. General American has used it successfully on caustic soda tanks in New Jersey, on steam lines in Chicago and in other applications at Pasadena. They knew the low-cost, easy installation and long-life features of FOAMGLAS.

Write for free copies of the General American Fact Sheet and our new Industrial Insulation Catalog: Pittsburgh Corning Corporation, Department H-90, One Gateway Center, Pittsburgh 22, Pa. In Canada: 3333 Cavendish Blvd., Montreal, Quebec.

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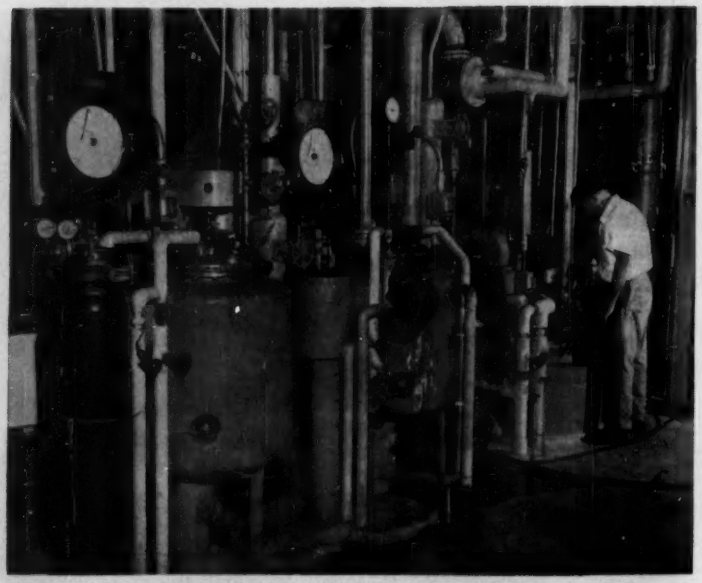


PILOT PLANT, where most processes prove out, can also indicate future operating problems and help provide some practical solutions for them.

state. Operating people—operators and supervisors—are far from obsolete and will be around for a long time to come.

Operations is the boss, maintenance the servant, in most plants today. But perhaps it would be more correct to say that it is a cooperative arrangement rather than a master-servant relationship. Operations must run the plant, but it must have the aid of the Maintenance Department if the plant is to keep running. In most plants today, the Maintenance Department schedules long-range maintenance and renovation, but does so in consultation with and at the sufferance of Operations. How often have you seen much needed major maintenance postponed again and again because the equipment could not be spared from the line?

Indeed, to cite an extreme, we have seen a plant that produced a high-profit, high-volume material run to death. The only maintenance done was on an emergency, high-cost basis and was aimed at keeping the plant running at all costs, held together with baling wire and chewing gum.

In an uncertain market where you must get what you can while you can, such an approach is feasible because lost production can cost you more than the value of your equipment and you may find your market gone when you are again ready to start up.

Such complete dominance of the scene by Operations is, of course, not desirable in normal circumstances — few markets are such that it is cheaper to destroy the plant than to shut down occasionally for major maintenance. Therefore, in the normal plant, Operations and Maintenance work together to keep the plant running at maximum efficiency.

▶ **Operator Maintenance** — It seems far more sensible to permit operating people to do minor maintenance than to have maintenance people running the plant. An operator with a wrench or two in his hip pocket can handle many small maintenance problems, such as tightening pump packings or tubing fittings. But we don't believe maintenance people are competent to run a balky evaporator on the edge of foaming over, nor should they be.

If trouble with the equipment is the result of malfunctioning instruments or other breakdowns in auxiliary equipment, then certainly the Maintenance Department should be called upon to fix it. But often the malfunction is not so serious that the operation must be shut down and Operations must then run it in spite of the difficulty. This is where the practical experience and know-how of the operating man comes to the fore.

Over a long period of operation, process equipment wears out, corrodes, plugs up and generally deteriorates in numerous ways, with consequent deleterious effect on production rates. But production rates must often equal or even exceed the original design rates, though the plant grows older and the equipment becomes obsolete. It is the responsibility of the operating men to see that the plant not only produces at this maximum rate, but that it produces economically.

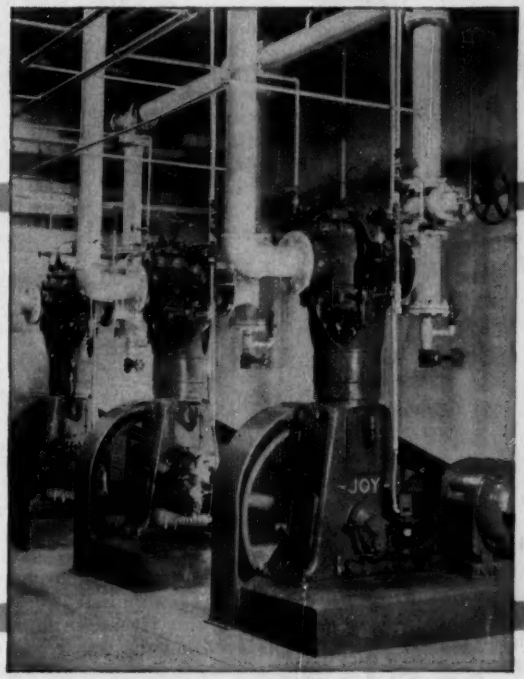
Thus, operating men learn a great many tricks over the years, some of them applicable only to a particular plant or an individual piece of equipment, some universally useful.

▶ **Operating Men Reticent**—But these operating tricks, learned the hard way, are often jealously guarded. Operating men, unlike the maintenance fraternity, seem to be a rather reticent lot. There are no societies or associations of operating men equivalent to the Maintenance and Plant Engineering Division of the ASME or the American Society of Plant Engineers where operating men can get together and deliver papers on the problems of keeping a plant running. Operating men tend to keep their knowledge to themselves.

Such knowledge as they do pass on is transmitted by word of mouth or in in-plant communications like operating manuals or trouble-shooting instructions for a particular process or piece of equipment. Thus operating knowledge tends to become a mystical tradition, passed on by its practitioners from generation to generation, propagating vertically in linear descendence rather than disseminating broadly throughout the industry. Operating men,

FOR OIL-FREE AIR WITHOUT EXCESSIVE MAINTENANCE

JOY WGO-9 COMPRESSORS



A continuous supply of oil-free air is guaranteed by this multiple installation at a midwestern container factory. Vertical design means reduced maintenance . . . the piston ring need never be rotated.

This Joy WGO-9 supplies air free of contamination because it uses no lubrication in the cylinder. Lubrication is eliminated by the use of carbon-graphite or teflon piston rings. Exclusive piston ring design (patents pending) gives ring life of 8000 operating hours, and more. Joy has more than 20 years of experience with these special compressors, and as a result, has developed 14 sizes of the WGO-9 to meet your every requirement. Capacities run from 95 cfm—15 hp, to 939 cfm—75 hp. For larger volumes of oil-free air you can specify the WN series, up to 600 hp, 3696 cfm.

Get complete details on the Joy WGO-9, one of a complete line of compressors for industry. Write for free bulletin 337-11.

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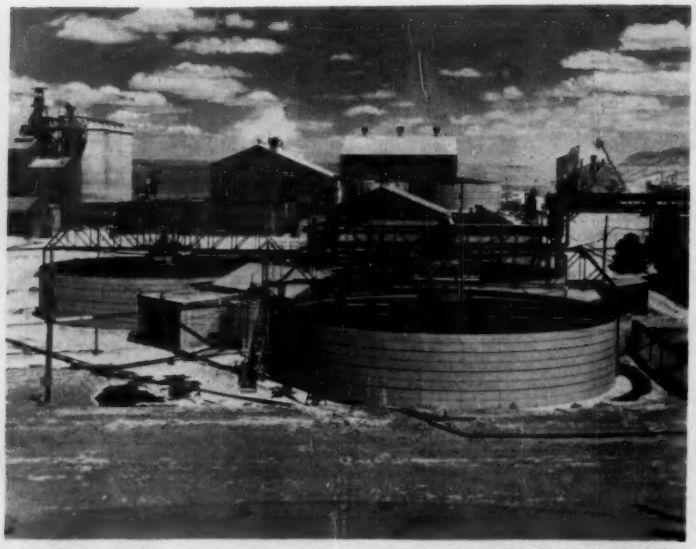


THICKENERS, quiet, not spectacular, can produce some difficult operating problems that require much practical know-how and experience to solve.

therefore, do not have the opportunity to pick and choose among many ways of doing things, but are tied to the ways they have taught themselves or have been taught by others.

▶**Trade Secrets?**—There are many reasons advanced for this state of affairs. The one most often heard is that operating information is secret information, that operating techniques that permit one company to produce at lower cost than another are too valuable to give away. But the same argument can be applied to maintenance techniques that reduce one company's maintenance costs below that of another.

Yet maintenance men have no hesitation whatever about revealing at great length those maintenance techniques found valuable in their own plants. The thought that they might be giving away information that will benefit their competitors does not deter them from holding many conventions at which they deliver great numbers of papers on every conceivable aspect of maintenance, plant engineering and inventory control.

Information relating to operation of specific items of equipment or to specific processes can be valuable to operating men everywhere. Just as the maintenance men seem to place pride in their common profession above their selfish interests and therefore gladly pass on to their colleagues everywhere whatever they learn in the course of their work, so also should operating men be equally generous with their hard-earned knowledge.

While reluctance to betray "trade secrets" is one reason for the scarcity of operating information in print, it is not the only reason.

▶**Define Trade Secrets**—Operating men often feel that their work is too individual, too special, to be of much use or interest to their fellows elsewhere. They feel that case histories are too narrow in scope to merit circulation, that the story of "how we increased throughput in our No. 3 rotary filter," while very interesting to the principals, would be very uninteresting to other people. This is not necessarily true.

If No. 3 rotary filter handled only a rare pharmaceutical and the improvements were applicable only to this one product and no other, then the story would be of very limited interest. Indeed, this situation might qualify as a bona fide trade secret if it gave the company a distinct competitive advantage in its field.

But if No. 3 rotary filter handled any one of a number of common materials, and if the operating methods applicable to this one material were equally applicable to many others, then this information would be useful and interesting to many people besides those directly concerned. These specific operating techniques would not qualify as trade secrets any more than the widely applicable maintenance methods that maintenance men discuss so freely among themselves.

That which applies to No. 3 rotary filter also applies equally well to filters No. 1 and 2, to the evaporators, to the thickeners, and to every other piece of equipment and generally used process in the chemical industries.

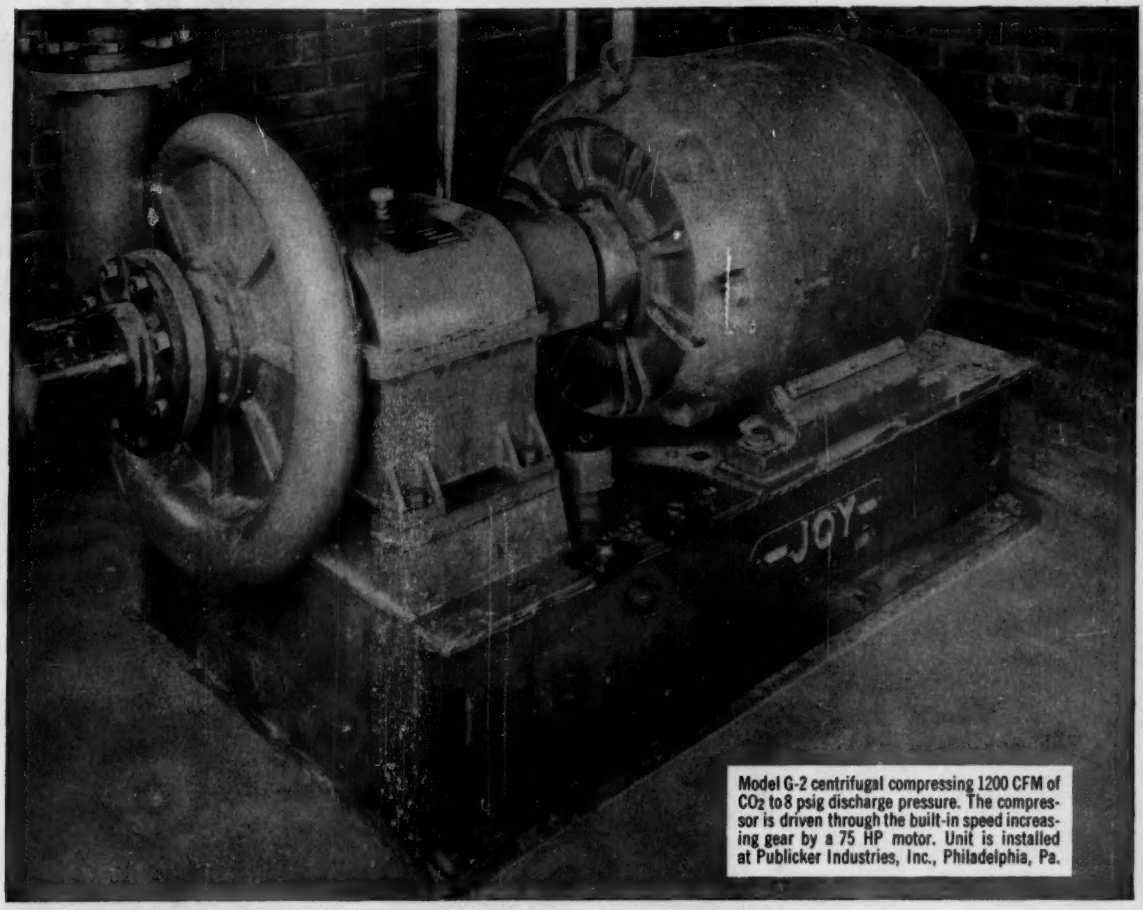
Operating Men, Share Your Knowledge!

Has it occurred to you operating men that your counterparts in other plants might have the same problems you have? These men would like to know how you handle plant operating problems and how your methods might apply to them. In turn, knowledge of how someone else has handled an operating situation may point the way to the solution of your problems.

Share your experience and knowledge with your fellow readers. Write an article for Operation and Maintenance. It's easy. Just write 4 to 12 double-spaced typewritten pages on some phase of plant operations with which you are familiar and send it in to us. We will do the rest. You will find that when writing on a familiar subject, the problem is not making it long enough, but making it short enough.

Address articles and correspondence to: Operation and Maintenance, Chemical Engineering, 330 W. 42nd St., New York 36, N. Y.

COMPACT AND EFFICIENT



Model G-2 centrifugal compressing 1200 CFM of CO_2 to 8 psig discharge pressure. The compressor is driven through the built-in speed increasing gear by a 75 HP motor. Unit is installed at Publicker Industries, Inc., Philadelphia, Pa.

JOY CENTRIFUGAL COMPRESSORS TAKE LESS THAN HALF THE SPACE

Joy Centrifugal Compressors are efficient and compact. Superior performance is the result of designs using advanced aerodynamic concepts and space-age metallurgy. The impeller is machined from a single alloy-steel or aluminum forging and keyed to an alloy steel shaft which is integral with the speed increasing gear. For compactness, the compressor casing is bolted to the gear casing.

The result of this design is trouble-free service with remarkable savings in maintenance . . . the maximum of compressed air or gas for the power consumed and floor space occupied.

Joy Dynamic Compressors are available in both centrifugal and axial designs, with a capacity range from 15 to 15000 HP. For complete details on how Joy Centrifugal and Axial Compressors can save space and money on your compression requirements, write for bulletin 1491-11.

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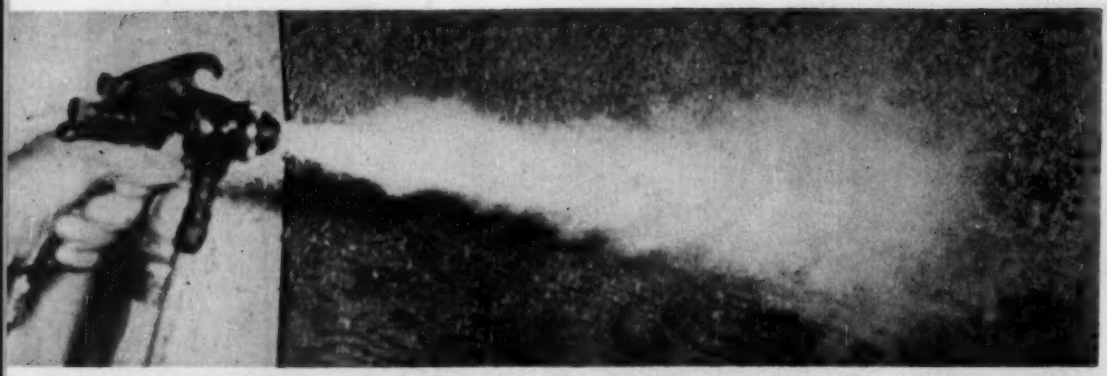


SPRAY GUN ejects new glass-flake coating; builds up 30-mil thickness.

Glass Flakes: Key to New, Strong Coating

Multiple layers of glass in resin produce a hard, thick, resistant coating on process equipment. The glass-resin "premix" is easily sprayed on with standard equipment.

The wraps are finally off a long-rumored development in corrosion protection: a "reinforced" spray coating containing glass flakes.

Developed by Owens-Corning Fiberglas, the just-introduced coating produces a hard, thick barrier consisting of multiple layers of glass (for strength) interleaved in a polyester resin (for chemical resistance).

Working equally well on metals, wood and concrete, the new product looks like a good bet for protecting chemical and oil storage tanks, duct work and concrete pipe. Other possibilities: as a liner on industrial flooring, as a water sealant for concrete block and slab walls.

► **Unusual Combination** — None of the "ingredients" in the O-C coating are exactly new. Glass flakes have been around for some time and people have been using polyesters for many years. What's unusual here is the combination of glass flakes and resin in a sprayable coating. The one major benefit of such a union: very thick coatings become possible.

Most experts agree that for aggressive corrosion conditions only a thick coating will do a decent job—thin coatings will usually have pinholes, which become focal points for attack. But there's a limit to the thickness of even a heavy-duty rubber-based coating—6 mils is considered pretty good. However, 20 or 30 mils with the new glass-polyester product is no trick at all.

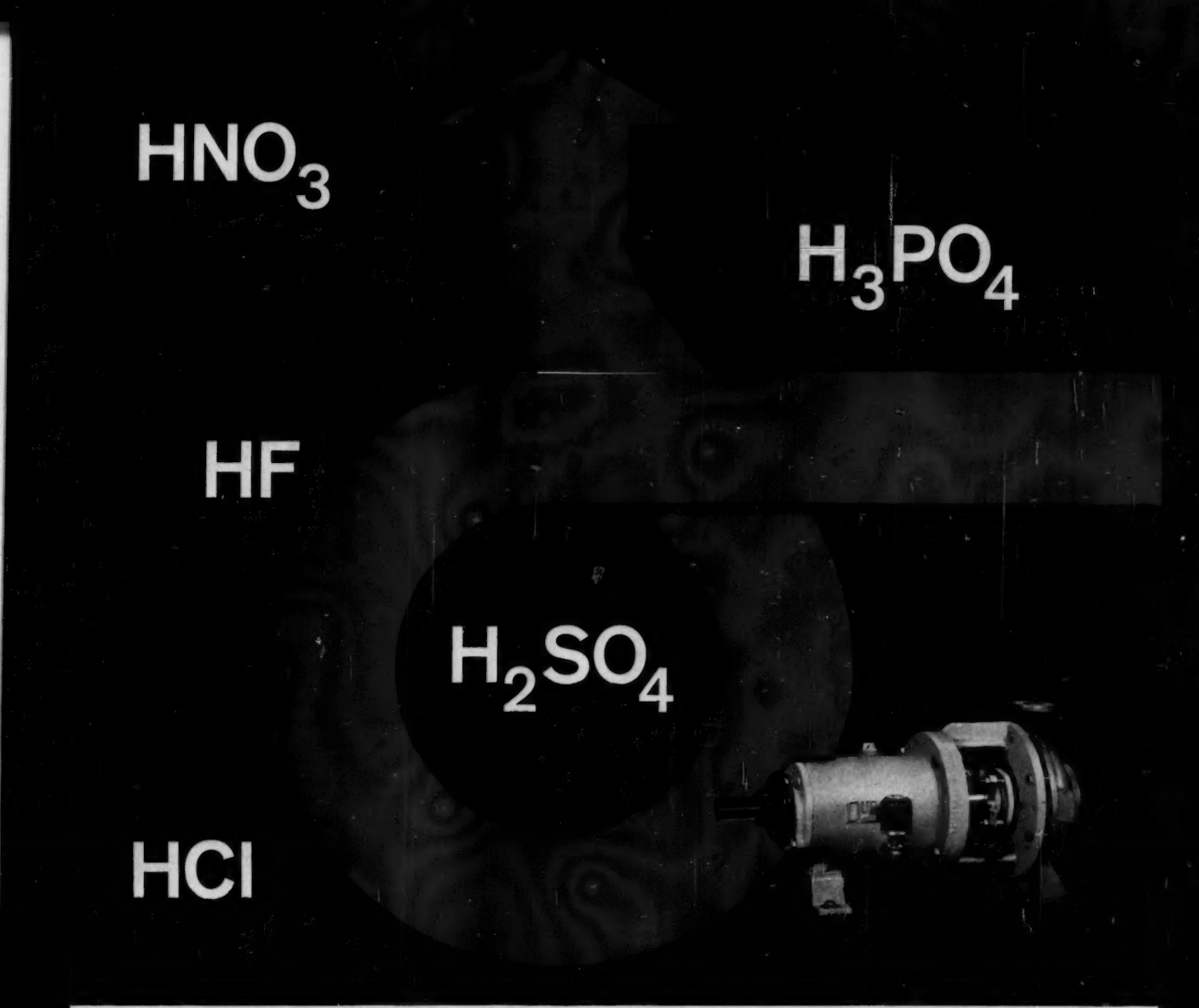
The strength-giving glass flakes prevent sagging on vertical surfaces, minimize shrinkage, prevent pinholing and produce a tough, impact-resistant surface.

Each flake is about 0.00008-in. thick, manufactured from borosilicate glass specifically compounded for acid resistance, ultraviolet capacity and weatherability.

There are about 50 glass layers in a 20-mil coat. The coating is self-curing (with a catalyst) and

Important Properties of Glass-Resin Coating

Specific gravity	1.5 to 1.6
Vapor transmission	Less than 0.01 perms
Combined shear strength	1,200 psi.
Tensile shear strength	500 psi.
Dielectric strength	500 volts/mil
Linear coef. of expansion	12–16 X 10^{-6}/°F.
Specific heat	0.31–0.33
Flammability	Burns slowly
Shelf life	3 months
Cure	Minimum ½ hr.
Coverage at 30 mils	4 sq. ft./lb.



Specific design for pumping corrosives

Durcopumps have been specifically engineered for pumping process chemicals under highly corrosive conditions. For most concentrations and temperatures used industrially you can get a standard model Durcopump to meet your specific process and volume requirements.

Pumps are available in fourteen alloys and special materials. Heads to 345 ft., capacities to 3500 gpm.

For advice on your specific application call your local Durco Engineer or write for Bulletin P-4-100.

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How Glass-Polyester Coating Resists Chemicals

Nomenclature

- E Excellent, no attack.
- G Good, no appreciable attack.
- F Fair, slight attack, use where limited service is justified.
- P Definite attack, use only in special cases.
- NR Not recommended.

	78 F. or Less	160 F.	212 F. or Boiling Point If Lower
Acetic acid 10%	E	E	F
Acetic acid 50%	E	G	F
Acetic acid 75%	F	NR	NR
Acetone	E	G	F
Alcohol, amyl	E	E	E
Alcohol, benzyl	G	P	NR
Aluminum potassium sulfate	E	E	E
Aluminum sulfate	E	E	E
Ammonia aqueous 5%	G	P	NR
Ammonium bicarbonate	E	G	F
Ammonium carbonate	E	P	NR
Ammonium chloride	E	E	E
Ammonium hydroxide	G	F	NR
Ammonium nitrate	E	E	E
Ammonium persulfate	E	E	G
Ammonium sulfate	E	E	G
Amyl acetate	G	F	P
Aniline sulfate	E	E	E
Benzene sulfonic acid	E	E	E
Benzoic acid	E	E	E
Chlorine dioxide bleach	E	E	E
Chlorine water saturated	E	E	F
Chloracetic acid	E	G	F
Copper chloride	E	E	E
Ethylene glycol	E	E	E
Fatty acids	E	E	E
Ferric chloride	E	E	G
Ferrous chloride	E	E	G
Fluorine	E	G	P
Formaldehyde	E	E	E
Formic acid 50%	E	....	....
Furfural	E	F	NR
Gasoline	E	E	E
Glycerine	E	E	G
Hydrochloric acid	E	G	F
Hydrocyanic acid	E	E	G
Hydrogen peroxide 10%	E	G	F
Hydrogen peroxide 30%	G	F	P
Hypochlorite bleach	E	E	G
Methyl ethyl ketone	E	G	NR
Nitric acid 5%	G	F	P
Nitric acid 20%	G	F	NR
Perchlorethylene	F	P	NR
Phenol 10%	E	F	NR
Phosphoric acid	E	E	G
Phthalic anhydride	E	E	G
Sodium acetate	E	E	G
Sodium bicarbonate 10%	E	G	F
Sodium carbonate	E	F	P
Sodium chloride	E	E	E
Sodium hydroxide 10%	E	F	NR
Sodium hypochlorite	E	E	G
Sodium nitrate	E	E	G
Sodium sulfate	E	E	G
Sulfuric acid 10%	E	E	G
Sulfuric acid 50%	E	E	G
Sulfuric acid 70%	G	F	P
Toluene	G	F	NR
Water	E	E	G

contains no diluting solvents.

▶ **Unique Premix** — Actually, there is one other novelty here. The idea of spraying glass and resin is not a new one (see *Chem. Eng.*, Sept. 7, 1959). But previous practice calls for a spray gun and glass chopper (the product is not a true coating). Resin and catalyst is pumped to the gun, while glass fiber is fed to the glass chopper. Then the resin contacts chopped glass just outside the gun, forming a laminate which falls on the surface to be coated. One big disadvantage of this technique, besides the cumbersome equipment, is the possibility of ending up with some uncoated glass, since the amount of resin that gets on the glass depends on many factors, including operator proficiency.

▶ **Spray, Then Roll**—In the new coating, glass, completely coated with liquid polyester, is already combined in a package or "premix" containing various fillers, pigments and accelerators (5- and 55-gal. drums). An air-driven pump* delivers this premix to a specially designed spray gun (De Vilbiss, Toledo, Ohio) where it combines with a curing catalyst. (The gun is kept about 2 ft. from the surface. Curing takes about ½ hr. at room temperature).

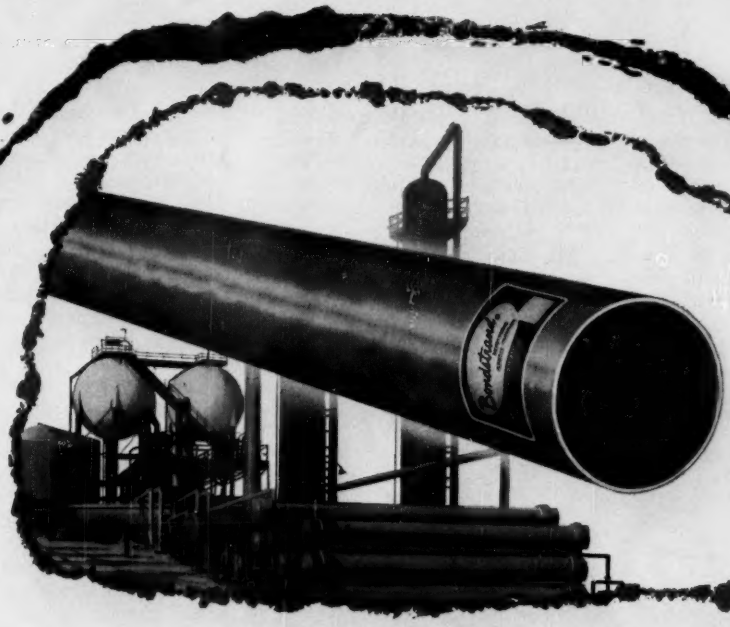
There is no problem with uncoated glass, but the coating does have to be rolled with a paint roller to orient the flakes, eliminate pinholes and to obtain a smooth surface.

Owens-Corning is first offering a polyester-based system, stressing that some polyesters are very resistant to chemicals (*see corrosion table*). But epoxy and other resin systems are under development.

The coating is being marketed initially by a limited number of applicators of corrosion-resistant coatings and distributors of Owens-Corning materials. It will be sold directly to industrial users in pilot-plant quantities.

▶ **Costs Favorable**—From a cost standpoint, the new material compares favorably with other coatings. The premix costs $1/lb.

*Total equipment needed: pump, spray gun, air compressor, pressure tank, air regulator, flow meter, and air and fluid hoses.



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From Missile Research...

A new product for process piping

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- 1/4 the weight of steel
- Inherently resistant to chemicals which attack stainless steel

Bondstrand is a corrosion-resistant, high strength, rigid pipe made of glass filaments bonded in chemically inert synthetic resins. It is capable of withstanding high pressure and the corrosive attack of many salt, acid, and alkaline solutions. The outside surface is equally resistant because the pipe is made entirely of corrosion-proof materials. No painting or maintenance is necessary.

Bondstrand's light weight and ease of assembly can save up to 50% of installation costs. Actual cost records of typical applications prove that the total installed cost averaged only 1.3 times that of carbon steel pipe. By eliminating the corrosion problem and down time for replacement or repair, Bondstrand saves many times its slightly higher initial cost.

Bondstrand is now available in sizes from 2" through 8" with all necessary couplings and fittings. Larger sizes available on special order.

Write for bulletin containing complete data, including physical properties, chemical resistance, flow rates, and other design information.

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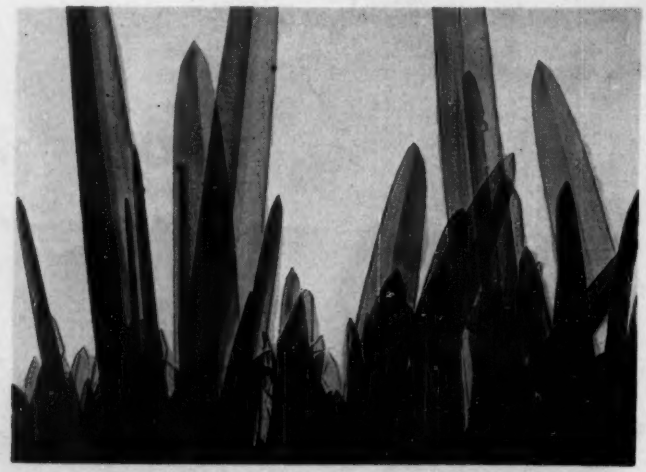
Coverage is about 4 sq. ft./lb. at 30 mils or 25¢/sq. ft. for material. An experienced coating crew can cover 400 sq. ft./hr. No priming or sealing coat is necessary.

▶**Some Precautions** — In handling the material, certain precautions have to be taken. For instance, the catalyst is a 60% solution of methyl ethyl ketone peroxide in dimethyl phthalate (then diluted with styrene). Contact with skin or eyes must be avoided, since this material is a very strong oxidizer.

Surface preparation is also vital. Metallic surfaces must be free of any foreign substances such as oil, grease, paint, mill scale. Small surface areas can be wire brushed, large areas need sandblasting if not clean.

New concrete should be cured at least four weeks prior to coating. Any oil contamination must be sandblasted. Concrete surface must be thoroughly dry.



DESTRUCTIVE crystals (300,000 mag.) spread across metal.

Oxide Blades Cause Iron Corrosion

New insights into iron corrosion show it's not all electrochemical. Whisker growth is a big factor.

Scientists at Westinghouse research laboratories have come up with a new basic explanation for the corrosion of iron. Westinghouse researchers Earl A. Gulbransen and T. P. Copan suggest that the true culprits are hydrogen ions, or protons.

▶**Hydrogen Culprits** — The hydrogen ions come from water vapor, which must be present if iron is to rust to any great extent at room temperature. Their theory suggests that the tiny hydrogen particles penetrate the iron and enlarge the sites at which oxygen normally combines with the metal. This spreads the reaction throughout the surface of the iron, causing it to rust destructively.

Until now, a standard explanation for iron corrosion is that it is an electrochemical reaction. Tiny local areas on the surface of the metal act as plus and minus electrical terminals under the influence of an invisible liquid film of water, generating minute electric currents that corrode the iron. The new theory suggests that something more fundamental takes place in the iron, even though an electrochemical reaction also may be present.

▶**New Theory**—In a series of experiments that eliminated the conditions required for electrochemical reactions, the Westinghouse scientists reduced the complex rusting of iron to its simplest atomic processes. Pure iron wires about as thick as a fine sewing thread were reacted with oxygen and water vapor at 835 F. under closely controlled, idealized conditions. Results of the minute-scale corrosion were studied with the help of an electron microscope (300,000 magnification).

▶**Whiskers on Surface**—With dry oxygen, iron forms a protective oxide coating from which grow billions of tiny round oxide whiskers less than one-millionth of an inch in diameter and 30-millionths of an inch high. Each whisker grows from a single, specific growth site on the wire's surface.

Then the wires were reacted under identical conditions except that water vapor was substituted for the dry oxygen atmosphere. Moisture produces a startling change in the oxide surface. From the growth sites erupt thin, pointed, blade-shaped platelets of iron oxide that spread across the metal surface. Shaped somewhat like blades of grass, they are about one-millionth of an inch thick, 30-millionths of an inch wide and 300-millionths of an inch high. As they grow in size, they spread more than 50 times in area over the sites observed for dry oxygen alone, reaching a density of nearly 1 billion/sq. in. of metal surface area.

The experiments show that less than one part of water vapor in 200 parts of the dry oxygen atmosphere will cause the blade-shaped crystals to form. At room temperature, this would correspond to a relative humidity of about 3%.

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One source for both horizontal and vertical furnaces for every process need

With the addition of the K. W. Anderson Co. of Tulsa to its Petro-Chem Development Division, Yuba offers its customers a complete line of internationally preferred heaters. Manufacturing both the Anderson horizontal UNI-RAD heater and the Petrochem ISOFLOW heater, Yuba now becomes the largest single, fully integrated source of supply of heaters to the petroleum, chemical and petrochemical industries.

From its new central location in Tulsa, Yuba's expanded Petro-Chem Development Division designs, builds, erects and services both types of furnaces for the process industries—everywhere in the nation. For unmatched experience, products and services—you can count on Yuba, from planning through completion.

OTHER YUBA PRODUCTS FOR THE PETROLEUM, CHEMICAL AND PETROCHEMICAL INDUSTRIES:

Adsco Expansion Joints
Transaire Air-Cooled Heat Exchangers
Shell and Tube Heat Exchangers
Southwest Floating Roof Tanks
Cone Roof Tanks
Columns and Towers
Pressure Vessels
Process Condensers
Custom Fabrication
Field Erection Services

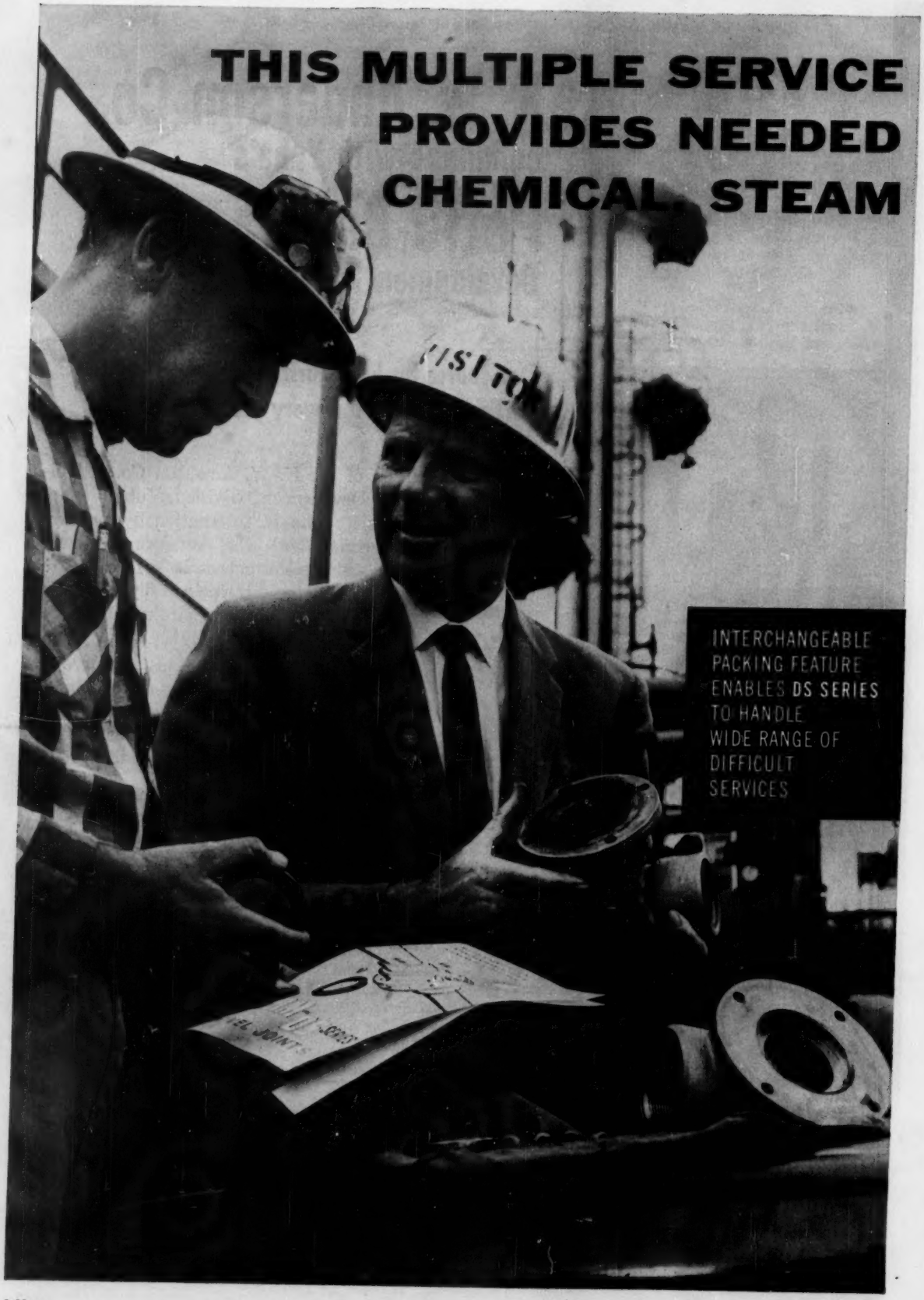
YUBA

specialists in process furnaces for every size, capacity and duty

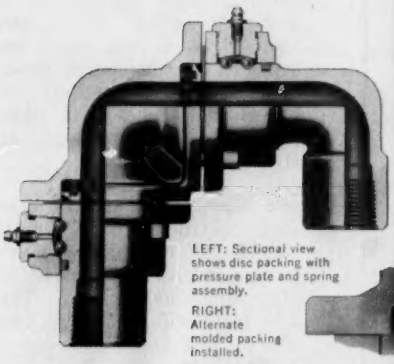
PETRO-CHEM DEVELOPMENT DIVISION

507 S. Quaker Ave., P. O. Box 660, Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.


THIS MULTIPLE SERVICE PROVIDES NEEDED CHEMICAL STEAM
INTERCHANGEABLE PACKING FEATURE ENABLES DS SERIES TO HANDLE WIDE RANGE OF DIFFICULT SERVICES

CHIKSAN SWIVEL JOINT FLEXIBILITY IN ALMOST ANY OR HOT GAS SERVICE



LEFT: Sectional view shows disc packing with pressure plate and spring assembly.

RIGHT: Alternate molded packing installed.

You'll find a good answer

to fluid line flexibility problems in the new Chiksan DS Swivel Joint. This versatile new joint offers maximum safety, complete flexibility and reduction of maintenance costs. Designed to use either disc or molded type packings, the DS Swivel Joint now permits packing changes in the line without removal of ball bearings.

You reduce your inventory

requirements because the same joint, with a change of packing, can be quickly adapted to any number of chemical, steam, or hot gas services in your plant. In large installations, substantial savings may be realized by reducing the inventory of joints.

Reduced maintenance costs...

Chiksan DS Swivel Joints require only routine lubrication to assure long service life. To save maintenance down-time repacking can often be done in the line. General servicing can be handled by regular shop maintenance personnel.

Let Chiksan help you

plan your installation design. Whether your need is for a chemical loading rack, for stress relief lines, for lines subject to expansion, settling or torsional stresses, or as a connection between stationary and rotating equipment, Chiksan field representatives are ready and qualified to render immediate technical assistance. For more information on these multiple service swivel joints, write to Chiksan or fill in the coupon below.

THE TABLE BELOW IS A QUICK GENERAL REFERENCE FOR THE CORRECT PACKING FOR SPECIFIC SERVICES:

PACKING	SERVICE	TYPE
Neoprene	Recommended for alkaline and acid salt solutions and aldehydes such as formaldehyde.	Molded
Hycar	These should be used for petroleum derivatives, neutral or slightly acidic salt solutions, dilute acids (Sulfuric to 50%, Hydrochloric and Nitric to 20%), alcohols, glycols, ethers, gases (Oxygen not over 500 psi), and vegetable oils.	Molded
Butyl	Recommended for liquid or anhydrous ammonia, gases (except oxygen over 500 psi), ammonia derivatives such as hydrazine and for certain hydraulic fluids such as Pydraul, Skydrol, and Cellulube. It is recommended for acetone and methyl ethyl ketone.	Molded
Teflon	For highly oxidizing fluids, esters, and ketones, and other fluids not handled by elastomers.	Disc
Asbestos	For use in saturated steam service.	Disc
Viton "A" (BBB)*	For high temperature fluids, aromatics, liquid chlorine and other halogens, tetra ethyl lead, chlorinated hydro-carbons such as carbon disulfide, molten sulfur, etc. Do not use for esters or ketones. This compound should give good service to 400°F.	Molded
Viton "A" (DDD)*	Recommended for strong acids such as concentrated sulfuric, red fuming nitric, and hydrochloric. This compound should give good service to 350°F. Do not use for esters or ketones.	Molded
Metallic	For extreme services such as hot gas at 600°F., a Stainles Steel metal disc, specially treated to prevent galling, is recommended.	Disc

* BBB and DDD are Chiksan compound identification letters.

MAIL COUPON NOW FOR COMPLETE DETAILED INFORMATION

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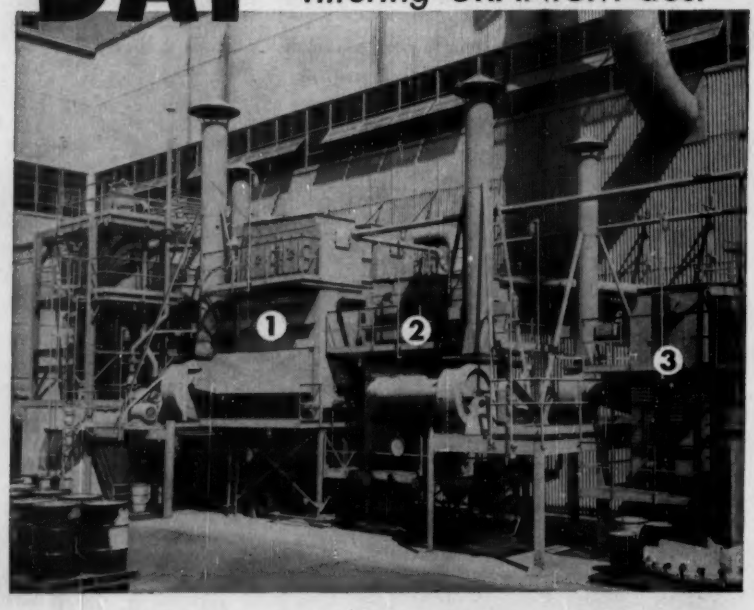
DAY *plant proven dust control filtering URANIUM dust*



3 DAY "AC" Dust Filters Serve MALLINCKRODT CHEMICAL WORKS

URANIUM DIVISION, AEC Weldon Springs Site

Shown above are 3 DAY "AC" dust filters. Filters No. 1 and 2 are collecting magnesium fluoride (M_gF_2) slag dust and U_3O_8 from slag grinding and similar operations. Filter No. 3, on the right, serves to filter uranium tetrafluoride (UF_4).

Equipment with high filtering efficiency is an imperative requirement for an installation of this type. These DAY filters meet this requirement. They capture sub-micron particles with 99.99+% efficiency because they are designed around the Hersey principle of air filtration which uses felted filter media. Filter media porosity is maintained automatically and continuously by high velocity reverse jet air. This assures stable back pressure.

Throughout many industries DAY equipment is preferred because it's *plant proven*. It means DAY not only offers high efficiency and pure, clean air but higher recovery of valuable product. DAY "AC" reverse jet filters are also preferred because they occupy a minimum of space and provide higher air handling capacities (4 to 5 times higher than non-reverse-jet type filters).

For more facts about the services and equipment DAY offers, consult your DAY application engineer, and for complete facts about DAY filters write toDAY for Bulletins F-75 and G-579. They contain helpful planning information and air engineering data.

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Dust Control • Pneumatic Conveying • Bulk Storage
EQUIPMENT . . . SYSTEMS . . . INSTALLATION

CPI BRIEFS . . .
(*Continued from p.* 58)

ruary, and the facility is to go on stream early in 1962.

Enjay Chemical Co., division of Humble Oil & Refining Co., announces that a 50% expansion of oxo alcohol capacity has been completed at the Baton Rouge refinery of Humble's Esso Standard Div. The expansion enables the refinery to make 90 million lb./yr. oxo alcohol and to add hexyl alcohol to its commercial product slate. Enjay markets the oxo alcohols, as well as other petrochemicals produced at Humble's refineries.

Foote Mineral Co. has authorized construction of a 20-million-lb./yr. electrolytic manganese unit at its plant site in New Johnsonville, Tenn. The new plant will be built in two stages, and the first stage—having a 10-million-lb./yr. capacity—is expected to be on stream around the end of next year. The completed unit will cost over $6 million. This expansion will be the third that the company has undertaken since 1956.

Continental Oil Co. will spend $2.2 million in a program to expand its research and development facilities at Ponca City, Okla. Main features of the program will include doubling the size of the existing main research laboratory and adding some 135 scientific personnel in the next five years. Work on the new facilities will start late this fall.

Food Machinery & Chemical Corp. is expanding manufacturing facilities at its Baltimore chemicals complex. The program includes erection of new units to produce Dimazine (a rocket fuel) and Tedion (a miticide), and also expansion of an existing Dimazine plant. Fluor Corp. is handling the $4-million program for FMC, and construction of the facilities is under way.

Pennsalt Chemicals Corp. announces that it has completed modernization of chlorine-caustic facilities at its plant

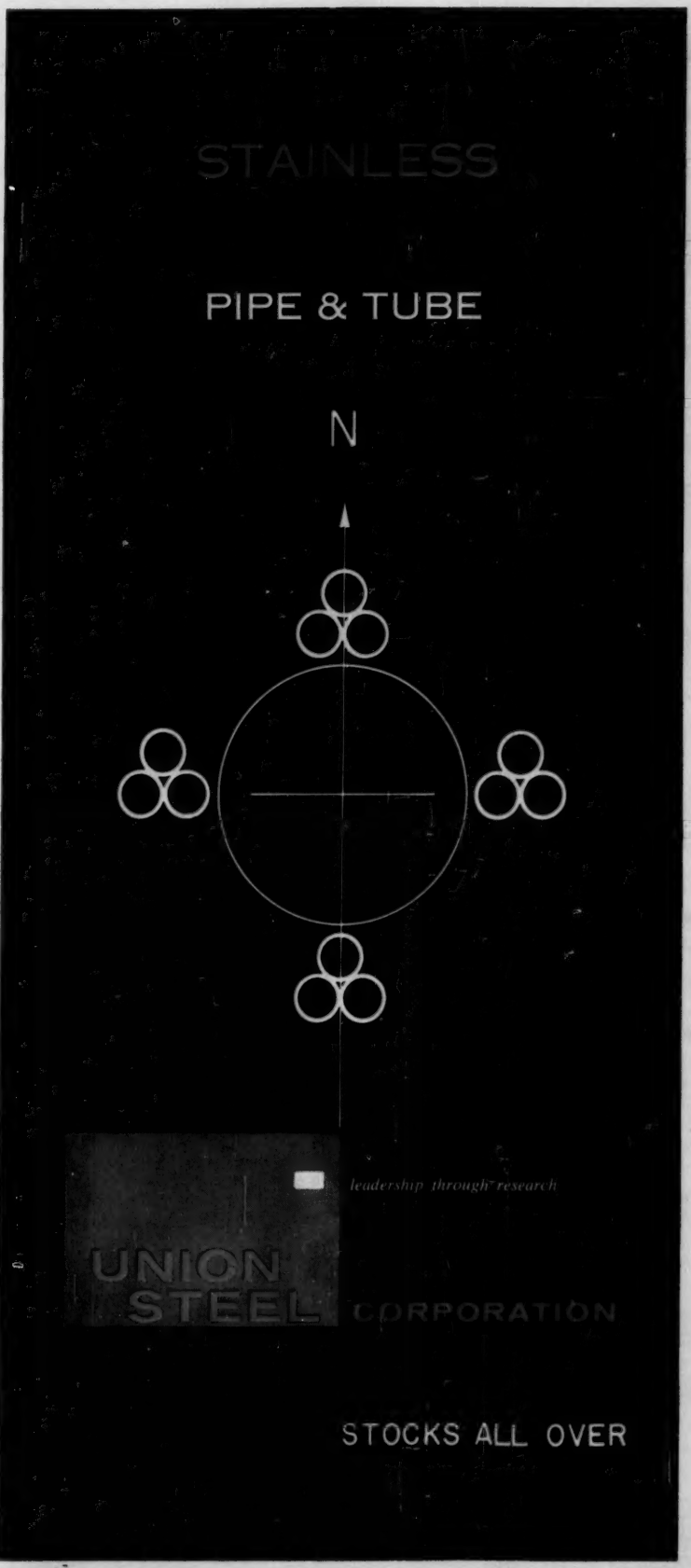
in Wyandotte, Mich. The $6-million program includes new equipment for treating brine and evaporating caustic, as well as 200 modern 30,000-amp. electrolytic cells which replace some 5,000 older diaphragm-type cells.

Reichhold Chemicals, Inc., is building a plant at Carteret, N. J., to make phenolic molding compounds. Company bought the plant site, consisting of 40 acres of waterfront property, from U.S. Metals Co., and will erect additional chemical plants on the property in the future.

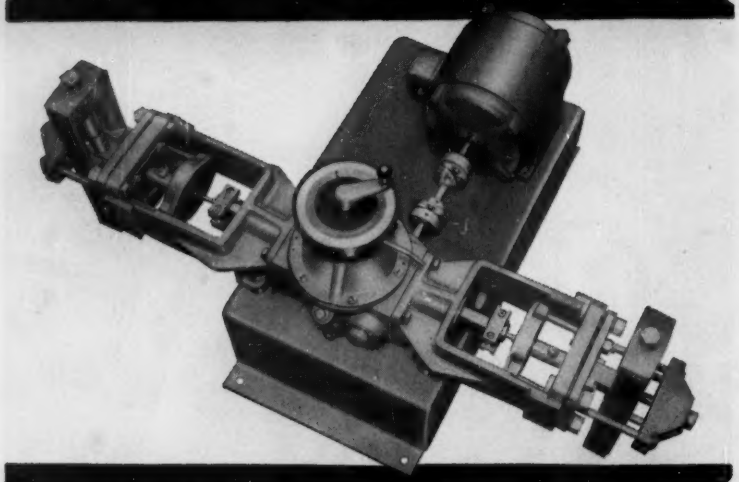
Susquehanna-Western, Inc., subsidiary of Susquehanna Corp., Chicago, will erect a $2-million plant near Falls City, Tex., to process uranium ore, following a recent contract between Susquehanna-Western and the AEC. Facility will have rated capacity of 200 tons/day ore, will convert the ore to a concentrate known as yellow cake for sale to the AEC. It is to be completed about nine months from now.

Dow Chemical Co. of Canada Ltd. is building two new chemical plants, both to go on stream next year. One is a phenol facility, to cost $3-4 million, that Canadian Bechtel, Ltd., will construct for Dow on Tilbury Island, near Vancouver, B. C. The other plant will be at Fort Saskatchewan, Alta.; it will initially make pentachlorophenol and dichlorophenol, will later add glycols and ethanolamines to its product slate.

Lignosol Chemicals Ltd. has formally started up plant additions totalling $1 million at its operation in the city of Quebec. The additions double the output of the plant, which treats spent liquor from sulfite pulp manufacture to produce a variety of chemicals. Included among the new facilities are a spray dryer (reportedly one of the world's largest), a second thermal compression evaporator, and



We Researched Over 15 Industries



Before We Designed This New Pump

From Maine to Texas we explored refineries, paper mills, pharmaceutical and chemical plants. Everywhere we found that metering operations—from pilot plants to proportional blending—were automated, efficient, ingenious. But there was room for an improved plunger pump. A pump that would give more flexibility and convenience in modern metering operations . . . positive accuracy and dependability in metering bland or harshly corrosive liquids against pressure.

Because it's designed around these critical needs, the new Wallace & Tiernan Series 200 Metering Pump fills the bill. Here's how:

Flexibility Drive units may be ganged to meter several liquids. One, two, or three liquid ends on one drive increase capacity and smooth out pumping pulsations. Six stroking speeds, several plunger diameters, and many liquid-end materials add further flexibility. "Stop-Adjust" and "Run-Adjust" models are available. On the latter, automatic stroke-length control, including ratio control, is easily achieved.

Convenience For different capacities or liquids, self-aligning liquid ends are quickly changed as complete units—a real convenience in pilot plant study. Bases for the Series 200 Pump may be steel plate, pipe, or structural shapes. A unique arrangement of eccentrics drives the plunger. This eliminates rocker arms and makes for the responsive, convenient stroke-length control industry needs.

Dependability The Series 200 Pump's design and materials mean resistance to wear and corrosion, less maintenance, and dependable operation. The drive is powered by a standard electric motor. Heavy ball bearings, forced-feed lubrication, and no cantilever bearing loads also assure long-lasting dependability.

Accuracy The Series 200 Pump meters accurately against up to 4,000 psi in the lower ranges (minimum 0.65 gph). And it meters any set amount, time after time, within ±1%—the kind of accuracy modern quality-controlled blending must have.

In every feature, the new Series 200 Pump is designed with modern industrial processing in mind. Component by component and feature by feature, you, the industrial user, called the shots. You specified the new W&T Series 200 Metering Pump.

For more on this user-inspired pump, write today to Dept. L-5.29

WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

additional laboratory and office space.

Hawaiian Electric Co. has acquired a 445-acre site in Kaho Valley, near Honolulu, where it plans to build a 100,000-kw. atomic power plant. Construction is to start about three years from now and to be completed around 1967. In the meantime, the company will erect a conventional power plant on the site. The conventional plant will cost $19 million, will be rated at 82,500 kw. and will be in operation by around 1963.

Calaveras Cement Co. has called bids for construction of a cement plant and associated facilities at Redding, Calif. Total investment will be over $14 million, and the facility is to start producing late next year.

Columbian Carbon Co. will build a plant near Houston for producing dispersions of carbon black in polyethylene, polypropylene and other resins. It is expected to begin operating in the fourth quarter of this year, is designed for a capacity of about 8 million lb./yr. of cable and plastic pipe grades of concentrate. The new plant will supplement Columbian's current operations in Tacony, Pa.

Pennsalt Chemicals Corp. has started operations in a new blending, warehousing and distribution center in Atlanta. The fourth such center that Pennsalt has built since 1955, the facility will serve the Southeast with the company's full product line.

Hercules Powder Co. announces that construction is almost completed on explosives plant at Gilbert, Minn. The plant will make commercial explosives specially designed for use on the Mesabi iron range.

Reichhold Chemicals, Inc., will build a new plant to make vinyl monomer under a license agreement entered into with Wacker Chemie GmbH. of Germany. Plant will have in-

itial annual capacity of 50 million lb., but Reichhold plans to expand this figure later to 100 million lb. Location of the new facility will be announced later; it depends on negotiations now under way with several acetylene suppliers.

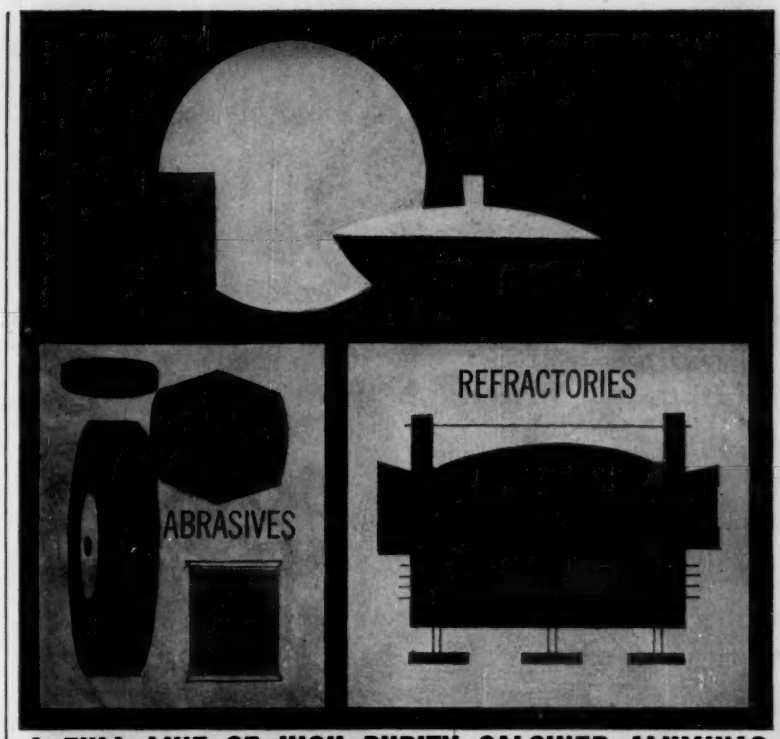
Houston Chemical Corp. will build an 80-million-lb./yr. ethylene oxide plant at Beaumont, Tex. The facility will be designed and constructed by Scientific Design Co., Inc., and will use SD's direct air oxidation process. It will reportedly be the largest plant of its kind in the world.

Allied Chemical Corp. announces that construction is starting on a nylon yarn plant at Irmo, S. C., which will be operated by the firm's National Aniline Div. The multimillion-dollar plant will be completed late in 1961. It will produce fine-denier Caprolan yarn, increasing the firm's over-all nylon fiber capacity to over 80 million lb./yr. Technical assistance and part of the manufacturing equipment for the Irmo plant will be furnished to Allied by the Italian fiber-producing firm Snia Viscosa, SPA, of Milan.

Union Tank Car Co. has started constructing 12 huge 30,000-gal. tank cars which it will lease to the Baton Rouge refinery of Humble Oil & Refining's Esso Standard Div. Introduced by Union Tank Car earlier this year, the new cars, which are called Hot Dog—30 cars, are said to be the largest-capacity in the world. Esso reportedly will use them to carry ethyl ether.

Atlantic Refining Co. is building an asphalt terminal at Three Rivers (near Syracuse), N. Y. The terminal will be supplied by barge, will have a storage capacity of 2.33 million gal. It is expected to be completed by the end of this year. Design, purchasing and erection are being handled by Badger Mfg. Co.

Hanson-Van Winkle-Munning Co., manufacturer of chemi-



A FULL LINE OF HIGH-PURITY CALCINED ALUMINAS

Kaiser Chemicals now offers you two grades of calcined alumina—KC-1 and KC-2—for manufacture of high-grade abrasives, refractories and ceramic products. These are high-purity, uniform quality aluminas, both grades available in coarse and fine particle sizes.

And for manufacture of electrical and electronic grade ceramics that require superior dielectric properties over a wide temperature range, Kaiser Chemicals offers grades KC-10 and KC-14. These are high-purity aluminas produced with very low soda content.

Typical Chemical Analyses:	KC-1	KC-2	KC-10	KC-14
SiO_2	0.02%	0.02%	0.10%	0.10%
Fe_2O_3	0.02	0.02	0.02	0.02
TiO_2	0.002	0.002	0.002	0.002
Na_2O	0.60	0.50	0.10	0.04
Loss on ignition	0.70	0.10	0.15	0.15
Al_2O_3 (by difference)	98.65	99.36	99.50	99.60

This wide range of top grade aluminas is designed to meet your specific performance requirements. For prompt service, or for specifications on any alumina product, call or write Kaiser Refractories and Chemicals Division, Kaiser Aluminum & Chemical Sales, Inc., at any of the Division Offices listed.

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Please send me your new technical brochure with complete information on the NEW Kaiser special alumina products to:

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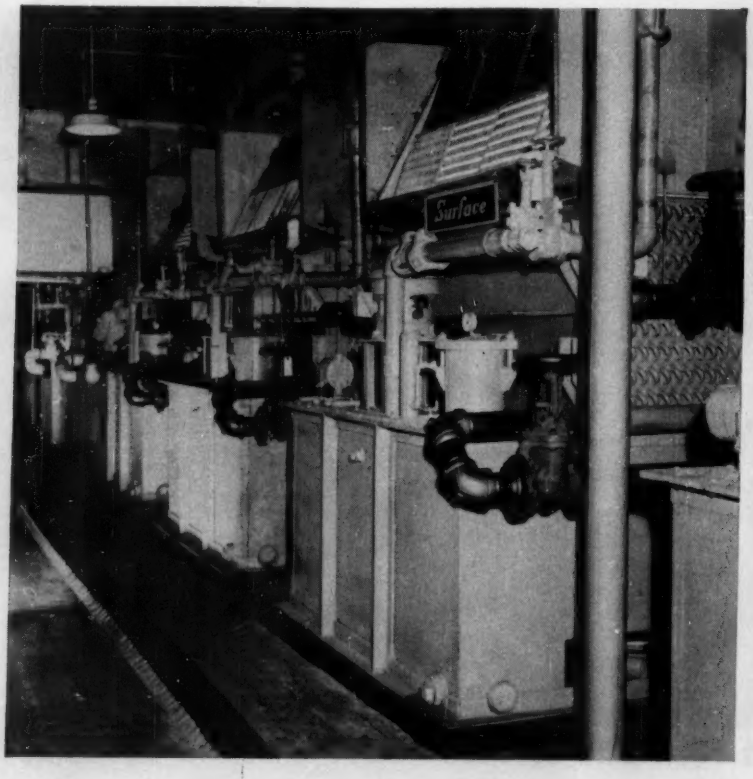

120 GRAINS CUT TO 45 IN 200,000 cfm OF AIR WITH 85° TOWER WATER

Without Kathabar, this job would have taken 1800 tons of refrigeration, at about 35F and reheating air from about 45F to 98F! With Kathabar the job took 63 hp instead of 2000. Ask the men who have seen Kathabar Type C units serve for years with practically no maintenance. Write for specific information.

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cals for the electroplating industry, has expanded manufacturing facilities at its Grand Rapids, Mich., plant. Company has increased plant production capacity from 15,000 to 45,000 gal./mo. by adding two reactors, filtration equipment and a 2,500-gal. mixing tank.

Chicago Bridge & Iron Co. has been awarded the construction contract for the Dept. of Interior's first demonstration plant for saline water conversion. The facility, to be located at Freeport, Tex., will make 1 million gal./day of fresh water by treating sea water in long-tube, vertical, multiple-effect evaporators. CB&I won the contract with a bid of $1,246,250.

Buckeye Cellulose Corp. has doubled chlorine dioxide generation capacity at its wood pulp mill at Foley, Fla., to 6 tons/day. Buckeye undertook the expansion because it expects a continued trend toward increasingly brighter kraft and dissolving pulps, requiring an ample supply of chlorine dioxide bleach.

Dyna-Therm Chemical Corp. has completed a new $100,000 research laboratory located at the company's Plas-Kem Div. in Burbank, Calif. The facility will aid Dyna-Therm's activities in the fields of high-temperature coatings, plastics, paints and plastisols.

Dow Chemical Co. will substantially increase its production of polyglycols at Freeport, Tex., by building a new plant. The current polyglycol plant there will be used for developing new products and making grades that have small sales volumes; the new plant will produce polyglycols mainly for the polyurethane market. It is scheduled for startup early next year.

AviSun Corp. has selected New Castle, Del., as the location for its forthcoming polypropylene plant. Site will be adjacent to the company's current film and fiber plants. Capacity of the polypropylene unit will be 100

million lb./yr. AviSun currently makes the polymer in a 20-million-lb./yr. unit at Port Reading, N. J.

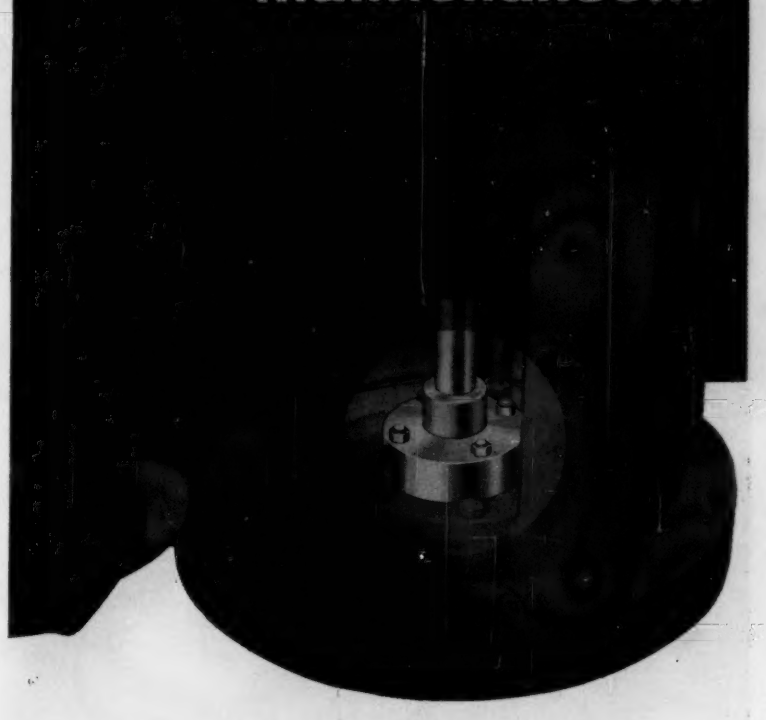
OVERSEAS BRIEFS

India: Synthetics & Chemicals Ltd., a company formed recently by Firestone Tire & Rubber Co. and Kilechand Devchand & Co. Private Ltd. (a Bombay banking and industrial firm), is building India's first synthetic rubber plant. The $30-million project will include units to make butadiene and styrene, and a copolymer plant to produce the final synthetic rubber product. Plant will have an initial capacity of 20,000 tons/yr., but will be capable of rapid expansion to 30,000 tons/yr. Selected site is near Bareilly, Uttar Pradesh; design and construction will be by The Lummus Co., New York.

Mexico: Celulosa y Derivados, S.A., Monterrey, has formulated plans to build hydrofluoric acid, carbon tetrachloride and fluorinated hydrocarbons plant at Monterrey. They are due to be completed early next year, will have sufficient capacity to supply both Mexico and other Latin-American countries. Except for limited production of hydrofluoric acid, none of these products are now made in Mexico. Technical information for the project will be supplied by the General Chemical Div. of Allied Chemical Corp.

Greece: A French-Greek group is blueprinting plans for the country's first aluminum complex. Included in the plans are an alumina plant with initial annual capacity of 100,000 metric tons, and an aluminum plant to produce over 50,000 tons/yr. The planning group

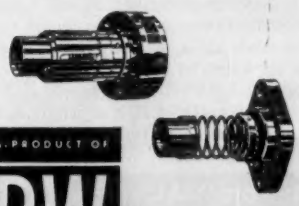
this simple seal gives lowest pump maintenance...



Save up to 66% of the time—expensive downtime—needed for installation or service of other mechanical seals used in plant process equipment.

The simple, effective Borg-Warner Type U Seal has no set screws—no close spring tension adjustments. It's fast and reliable.

For plants with a wide variety of pump service requirements, a minimum inventory of parts, and an easy change of gaskets adapts the Type U seal for service at temperatures of from −100 below zero to +650°F, and for pressures from 0 to 1000 psi.



Backed by Borg-Warner and proved in service, these dependable seals give complete safety, even in unattended stations.

Send for the latest Type U Seal engineering information—there's no obligation.

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Borg-Warner Mechanical Seals

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consists of the French aluminum firms Pechiney and Ugine, and the Greek shipping magnate Niarchos; it has been negotiating with Reynolds Metals Co., which may also join the venture. Cost of the two plants is estimated at $75 million, associated hydroelectric installations will reportedly cost an additional $125 million. The alumina plant will treat bauxite from Greek deposits.

France: Societe d'Energie Nucleaire Franco-Belge des Ardennes (SENA), a group of French and Belgian utilities firms, will build a 242-megawatt atomic power plant at Chooz, France, near the Belgian border. The plant will use a closed-cycle, pressurized-water reactor that will be designed by Westinghouse Electric Corp. Start-up is scheduled for 1965.

Mexico: The Borden Co., New York, and British Industrial Plastics, Ltd., London, will jointly form a new company to make amino molding compounds at a plant near Mexico City. Name of the new firm will be Materiales Moldeables S.A. de D.V., and its plant will have initial capacity of 1,000 tons/yr.

H. K. Porter Co., Inc., recently acquired Acieries & Ateliers de Construction de Marpent, a French producer of steel, railway cars and components, and other industrial products. The acquisition represents a big step in Porter's long-range program to firmly establish itself in international industry.

Intercontinental Chemical Corp., New York, American subsidiary of Farbwerke

Hoechst AG, Germany, has acquired the ethical pharmaceutical manufacturing company Lloyd Brothers, Inc., of Cincinnati. The acquisition marks Hoechst's first entry into pharmaceutical manufacturing and sales in the U. S.

United Carbon Co., Inc., Houston, has completed a process licensing agreement with **Sid Richardson Carbon Co.,** Fort Worth, Tex., under which latter company will use United Carbon processes to make oil-furnace carbon blacks. Richardson plans to build a 50-million-lb./yr. carbon black plant at Big Spring, Tex., which is due to be completed in mid-1961.

W. R. Grace & Co., New York, announces name changes for two of its eight chemical divisions. Grace Chemical Div.'s name becomes Nitrogen Products Div., and the former Dewey & Almy Overseas Div. is now known as the Overseas Chemical Div. Both name changes were made to reflect increased scope of operations of the two divisions.

Minnesota Mining & Mfg. Co. has recently purchased Revere Camera Co., Chicago. Revere's management and operating policies are to continue without basic change, and 3M's main aim in acquiring the firm is to enter the field of tape cartridge players for furnishing recorded music in homes.

Clark-Schwebel Fiber Glass Corp. is the name of a new firm recently formed by M. Lowenstein & Sons, Inc., Raymond F. Clark and Jack P. Schwebel. Clark and Schwebel have each served as executives for companies in the glass weaving industry, whereas the new firm marks M. Lowenstein & Sons' first entry into the fiber glass field. The new company will weave, finish and market industrial and decorative glass fabrics, will function as an independent affiliate of M. Lowenstein & Sons with headquarters in New York.

YOU DON'T HAVE TO SHOVEL IT...

USE MARASPERSE® AND PUMP IT!!

Use a little Marasperse® . . you'll find that a very small amount will make a thick aqueous slurry thinner, more pumpable. Or let you cut back on the slurry water, if you're shooting for higher drying rates later in the process.

Dispersion of insoluble solids is the answer. Marasperses prevent flocculation of small solids particles.

Same mechanism is responsible for eliminating, or slowing down, sedimentation of solids in dilute suspensions. If your products have to be suspended in water for use, Marasperse dispersants will keep them from settling. Or maybe you're making water-soluble formulations that become "contaminated" with insolubles during use. The Marasperses will keep the solids in suspension, increase the effective life of your formulations.

Ordinarily less than 3% Marasperse (based on the weight of solids in the aqueous system) will do the job for you. In some applications, only 0.1 to 0.2% is enough. And the Marasperses cost just a few cents a pound!

You can decide in a few minutes if a Marasperse dispersant will solve your suspensibility problems. The simple laboratory screening tests described in our literature tell you how. Write for Marasperse samples and technical bulletins.

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CHEMICAL SALES DEPARTMENT

MENASHA, WISCONSIN

MARATHON • A Division of American Can Co.
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Please send Information File No. E-90 ☐, Samples ☐ of MARASPERSE for use in

NAME_____

TITLE_____

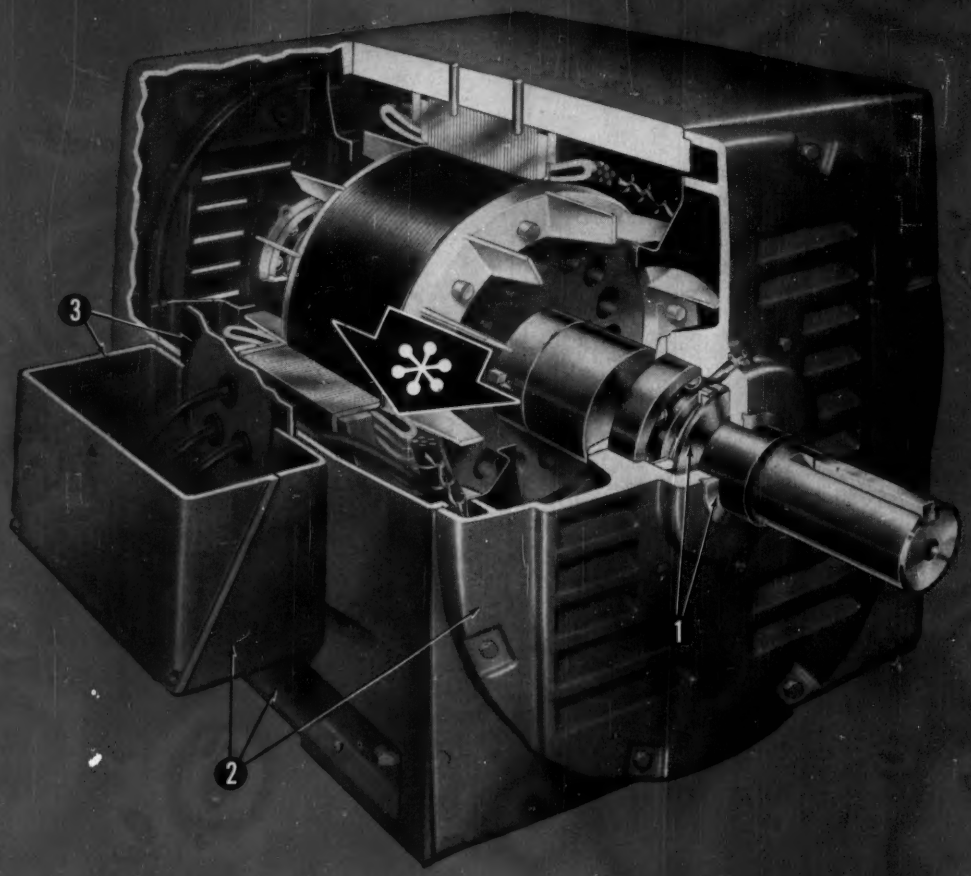
COMPANY_____

ADDRESS_____

Please attach to your company letterhead.

General Electric's CUSTOM '8000' means . . .*

MOTORS CUSTOM DESIGNED FOR THE CHEMICAL INDUSTRY



1 CUSTOMIZED BEARING SEALS guard CUSTOM '8000' motor bearings against the alkalies, acids, salts and other contaminants encountered in chemical processing applications.

2 FRAME, END SHIELDS, AND CONDUIT BOX are cast iron. All other parts and hardware are specially treated for corrosion resistance to provide maximum reliability in moisture-laden and corrosive atmospheres.

3 EXTRA-LARGE CAST IRON CONDUIT BOX has gaskets at the split, and between frame and box to seal out moisture. Leads enter box through rubber grommets to seal out ambient air.

IN ADDITION TO THE SPECIALIZED MOTOR FEATURES mentioned above, General Electric CUSTOM '8000' motors offer these superior "standard" features: easily-removable, lightweight, flat end shields simplify motor maintenance; "positive-purging" lubrication system increases bearing life—prevents grease leakage along shaft (new sleeve bearing design also available); pre-wound stator core assures uniform high performance; acoustic design reduces motor noise level.

CUSTOM '8000' MOTORS are manufactured to the rigid quality specifications General Electric has adhered to for over 80 years. Today, with the implementation of advanced design and manufacturing techniques, G.E. can accurately and economically *Customize* motors to your specific requirements through utilization of motor components engineered exclusively for chemical processing applications.

** Trade-mark of General Electric Co.*

MEDIUM AC MOTOR AND GENERATOR DEPARTMENT

GENERAL ELECTRIC

EXCLUSIVE

POLYSEAL * INSULATION SYSTEM LENGTHENS MOTOR LIFE

General Electric's new Polyseal supported silicone rubber insulation system is designed to give maximum winding protection against damage from the alkalies, acids, salts and other contaminants encountered in the chemical processing industry.

The Polyseal system assures superior mechanical, thermal, voltage and environmental endurance. This form-wound insulation is a vulcanized system "built-up" from silicone rubber tape reinforced by glass and Dacron† fabric. Polyseal both retains its resilience and provides a positive seal against fluids and other chemical processing contaminents.

POSITIVE MOISTURE PROTECTION is assured by "under water" production line tests. For example, 2300-volt, form-wound Polyseal coils are water soaked for one-half hour—then "hi-potted" at 8000-volts while still completely immersed—to prove the insulation system is absolutely sealed.

† *Registered Trade-mark DuPont Co.*

CALL YOUR GENERAL ELECTRIC APPARATUS SALES OFFICE

for full information on CUSTOM '8000' motors for the chemical industry, or write for Bulletins GEA-6865 and GEA-6889, to Section 884-11, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Convention Calendar

September

6-8. Chemical Institute of Canada, Nuclear and Radio-Chemistry Symposium, Chalk River Laboratories, Chalk River, Ontario.

6-16. Production Engineering Show, Navy Pier, Chicago, Ill.

6-16. Machine Tool Show International Amphitheatre, Chicago, Ill.

7-9. Massachusetts Institute of Technology, Joint Automatic Control Conference, Cambridge, Mass.

11-16. American Chemical Society, National Meeting, New York, N. Y.

12-13. New York University, College of Engineering, 6th Annual Titanium Metallurgy Conference, University Heights, Bronx, N. Y.

12-14. Canadian Agricultural Chemicals Assoc., 8th Annual Meeting and Conference, Britannia Hotel, Muskoka, Ontario.

12-16. Fifth International Instrument & Measurements Conference & Exhibition, Royal Institute of Technology, Stockholm, Sweden.

15-16. American Society of Mechanical Engineers, Engineering Management Conference, Chicago, Ill.

18-21. American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans, La.

21-23. American Society of Mechanical Engineers and American Institute of Electrical Engineers, Power Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

25-28. American Institute of Chemical Engineers, National Meeting, Mayo Hotel, Tulsa, Okla.

26-30. Instrument Society of America, Instrument-Automation Conference and exhibit, Coliseum, New York, N. Y.

27-1. International Electrostatics Conference, University of Grenoble, Grenoble, France.

October

5. Society of Plastics Engineering, Inc., Plastics vs. Corrosion, Mark Hopkin Hotel, San Francisco, Calif.

6-8. American Association of Textile Chemists and Colorists, 1960 National Convention, Sheraton Hotel, Philadelphia, Pa.

6-27. National Association of Corrosion Engineers. Six regional conferences:
6-7. West, Sheraton-Palace Hotel, San Francisco, Calif.
6-8. Southeast, Dinkler-Plaza Hotel, Atlanta, Ga.
11-14. Northeast, Prichard Hotel, Huntington, W. Va.
14-16. Canadian (Eastern), Sheraton Mount Royal Hotel, Montreal, Que.
19-20. North Central, Pfister Hotel, Milwaukee, Wis.
25-27. South Central, Mayo Hotel, Tulsa, Okla.

6-8. American Ceramic Society, Refractories Division Meeting, Bedford Springs Hotel, Bedford, Pa.

9-12. American Society of Mechanical Engineers, Rubber and Plastics Conference, Hotel Lawrence, Erie, Pa.

9-13. Electrochemical Society, Annual meeting, Shamrock Hotel, Houston, Texas.

12-14. American Vacuum Society, 7th National Symposium, Cleveland-Sheraton Hotel, Cleveland, Ohio.

12-14. Industrial Management Society, 9th Annual Methods Improvement Clinic, Conrad Hilton Hotel, Chicago, Ill.

13-14. Industrial Management Society, 24th Annual National Industrial Engineering and Management Clinic, Conrad Hilton Hotel, Chicago, Ill.

17-19. American Society of Mechanical Engineers & American Society of Lubrication Engineers, 7th Annual Lubrication Conference, Statler-Hilton Hotel, Boston, Mass.

17-19. Technical Assn. of the Pulp and Paper Industry, 15th Plastics-Paper Conference, Hotel Syracuse, Syracuse, N. Y.

17-19. Institute of Radio Engineers, 1960 Symposium on Adaptive Control Systems, Garden City Hotel, Garden City, L. I., N. Y.

17-21. American Society for Metals, 1960 Metal Show, Philadelphia Trade and Convention Center, Philadelphia, Pa.

19-26. International Plastics Exhibition, Ulrecht, The Netherlands.

20. American Institute of Chemical Engineers, New York Section, Annual All-Day Symposium, Hotel New Yorker, New York, N. Y.

23-27. Technical Assn. of the Pulp and Paper Industry, 156th Engineering Conference, Robert Meyer Hotel, Jacksonville, Fla.

25-27. American Standards Association, 11th National Conference on Standards, Sheraton-Atlantic Hotel, New York, N. Y.

26-27. Illinois Institute of Technology, 1960 Computer Applications Symposium, Morrison Hotel, Chicago, Ill.

27-28. The Fiber Society, Fall Meeting, Washington Hotel, Washington, D. C.

28. American Institute of Chemical Engineers, South Texas Section, 15th Annual Technical Meeting, Rice Hotel, Houston, Texas.

31. American Management Association, Packaging Management Course, Hotel Astor, New York, N. Y.

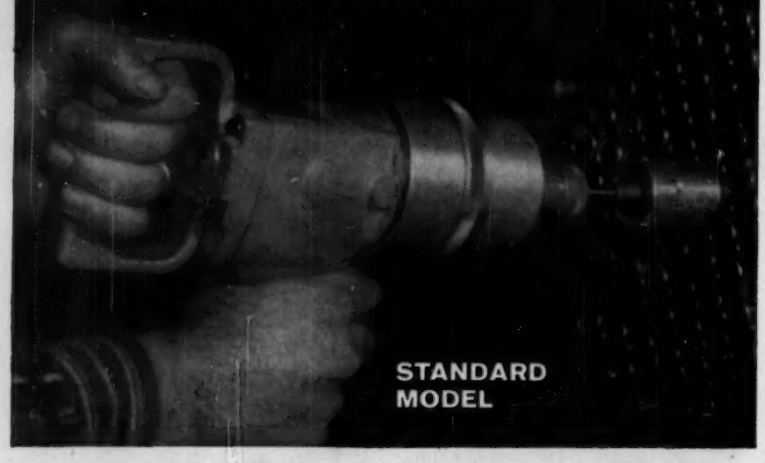
November

3-4. American Production and Inventory Control Society, 3rd Annual National Conference and Technical Exhibit, Sheraton-Cadillac Hotel, Detroit, Mich.

29-30. Midwest Research Institute and CHEMICAL ENGINEERING Symposium on new techniques in mathematics, chemistery and engineering as applied to modern chemical engineering practice, Hotel Muehlbach, Kansas City, Mo.

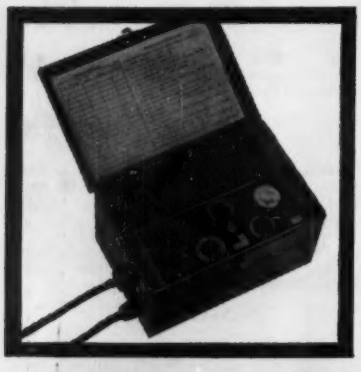
ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling



Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Electric Control ... Tube Expanders ... and Related Accessories



Elliott offers the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor. Also, a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 sizes, ranging from ¼ in. to 3½ in. O.D.

Other related accessories include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.

Write for descriptive literature *today*.

Y9-3

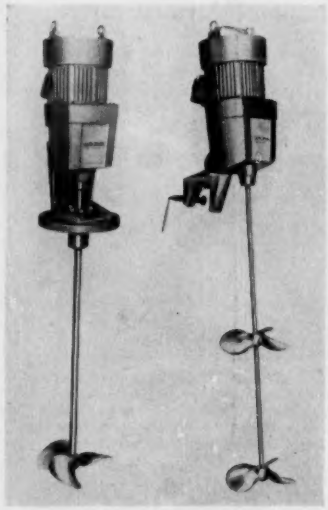
ELLIOTT Company
LAGONDA PLANT, Springfield, Ohio

NEW EQUIPMENT . . .

(*Continued from p.* 82)

erator" inside the inner gear that rotates inside it, deflecting it from a circular form into an elliptoid. Inner and outer gears have different tooth count.

In operation, rotation of the wave generator causes the flexible gear to counterrotate at a reduced angular velocity. Any two of the three elements may be rotated with the third one held fixed. Drive can thus transmit motion into a hermetically sealed vessel if the flexible gear is made part of the vessel wall. —**United Shoe Machinery Co., Boston, Mass.** 82C



Portable Mixer

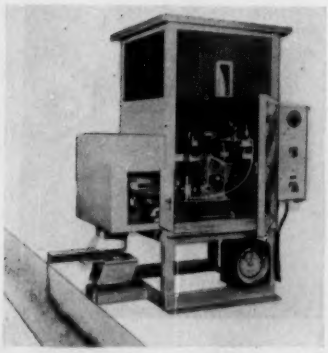
Propeller-type units are completely redesigned.

A complete new line of propeller-type mixers is said to offer increased mixing efficiency, improved handling convenience and maintenance-free operation for five years. Unique feature of "Lightnin" series is new drive chuck. Located above maximum fluid level, it couples with shaft in one easy operation.

Ball and clamp socket has position-indexing device that permits mixer adjustment through 90 deg. in the vertical plane and 360 deg. horizontally. All adjustments of the clamp and chuck are done with a

single Allen-type hex wrench.

Mixer, also available in fixed mounting design for open and closed tanks, comes in sizes ½ to 3 h.p at direct drive speeds of 1,750 and 1,150 rpm. Gear drive model runs at 350 rpm.—**Mixing Equipment Co, Rochester, N. Y.** 180A



Continuous Weigher

Automatic unit inserts dry solids in process streams.

High-concentrate additives are continuously weighed and inserted in process streams by new machine. It weighs precise amounts of any free-flowing solid in a net-weight hopper that dumps into a small secondary hopper. This, in turn, feeds the solids into a vibrating feeder, which transfers them to the main stream.

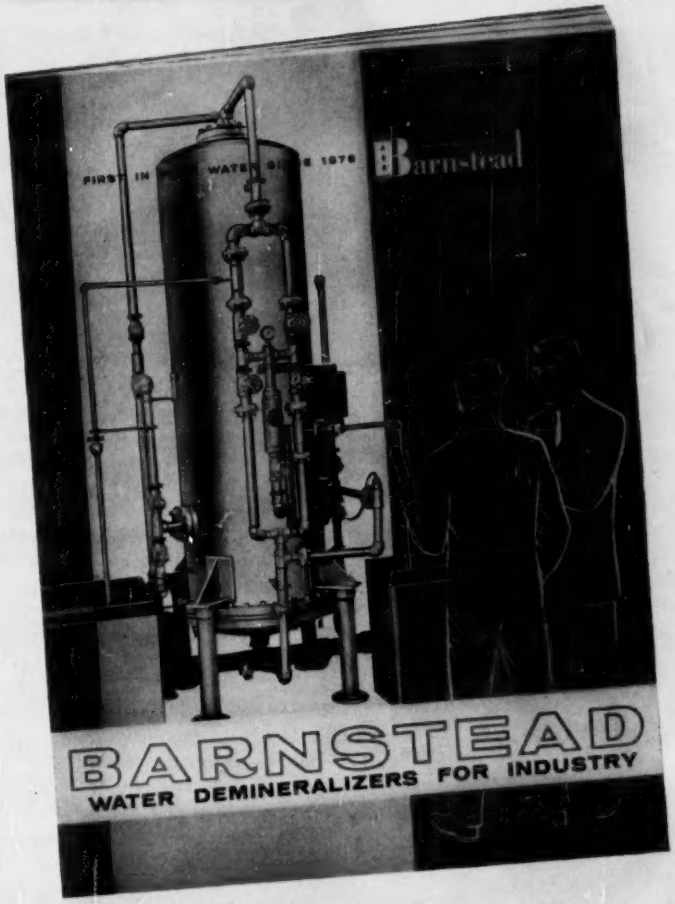
Multiple units are used to increase the number of weighings per minute without sacrifice of accuracy. Individual or combined chute discharge (electrically synchronized) may be used.—**Exact Weight Scale Co., Columbus, Ohio.** 181A

Formable Packing

Round, square types adapt to any size stuffing box.

Made of asbestos fibers and antifriction metals, a new packing is self-forming and self-lubricating. It makes itself into a solid, lead-like seal, the same shape as stuffing box or fitting,

BARNSTEAD DEMINERALIZERS FOR ALL INDUSTRIAL APPLICATIONS



DESCRIBED IN NEW CATALOG #160

This NEW 36-page Catalog features the complete line of Barnstead Mixed-Bed, Two-Bed, and Four-Bed Demineralizers with capacities of up to 2500 gallons per hour and more . . . built to your specifications. A special section of interest to Nucleonic and Electronic engineers is devoted to Barnstead "Train" equipment which produces ultra pure water of 18,000,000 ohms resistance at 25° C. This Pure Water equipment connected in series also removes organics, inorganics, bacteria, gases, and submicroscopic particles down to 0.45 micron. Other sections are devoted to Barnstead Tin-Lined Piping, Fittings, Faucets, Purity Meters, Storage Tanks, Sand and Carbon Filters, Submicron® Filters, and other auxiliary equipment.

Installation case histories of Barnstead "Pure Water Specials" are also described and illustrated. Charts, specification drawings and actual on-job installations are detailed. Write for your copy of Catalog #160 Today!

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STILL AND STERILIZER CO.
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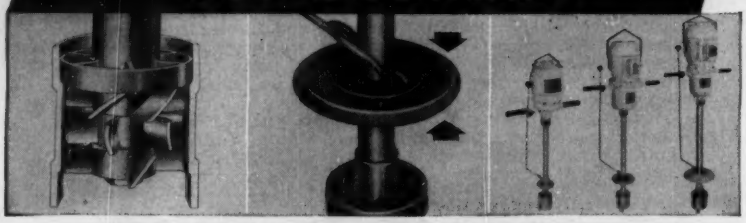
FIRST IN WATER PURIFICATION SINCE 1878

SHEAR-FLOW

Shear-Flow's high shear action produces finer, faster blending, dispersing and homogenizing. The new Model RL Shear-Flow portable mixer represents a major advance in mixer design. The new Hi-Shear Head consists of two rotating impellers and two stationary stators enclosed in a cylindrical housing. The fine clearance between impellers and stators results in rapid shearing action and a high degree of turbulence, resulting in a more complete reduction of agglomerates within the mixture.

- Greatly reduces mixing time
- Uniform circulation—no vortex
- Emulsifies immiscible liquids
- Controllable flow pattern
- Chemically inert seals
- Handles viscous materials with ease
- No operating torque

HAS A GOOD HEAD FOR BUSINESS



Close tolerances between impellers and stators promotes high shear for reduction and dispersion of material.

Adjustable deflector plate controls flow pattern for desired mixing action and air entrainment.

Three basic portable models for processing 1 to 250 gals. plus continuous mix units for high volume processing.

Write today for complete information on the Shear-Flow line of mixers.

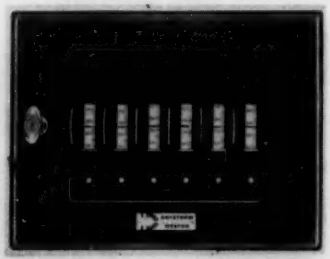
SHEAR-FLOW
GABB SPECIAL PRODUCTS INC.

GABB SPECIAL PRODUCTS INC.
Windsor Locks, Conn.

according to the manufacturer.

Binding materials and lubricants give the packing its formable qualities. It is extruded in round and square cross-section, comes with or without a braided asbestos jacket.

Style 200 is for steam, water and air, while Style 600 works best on chemicals, oils and petroleum derivatives. Price ranges from $4-8/lb., depending on size and style.—**Abbott & Biddle, Philadelphia, Pa. 181B**



Multipoint Controller

Stepping and memory circuit handles up to 6 channels.

A new multipoint, nonindicating controller with electrical contact control combines up to six measuring and control circuits in one instrument with a common amplifier.

Model 6134 periodically samples each measured variable and the related control setting, then compensates for deviation. Two- or three-position control and also differential gap control are available.—**Daystrom, Inc., Weston Instruments Div., Newark, N. J. 182A**

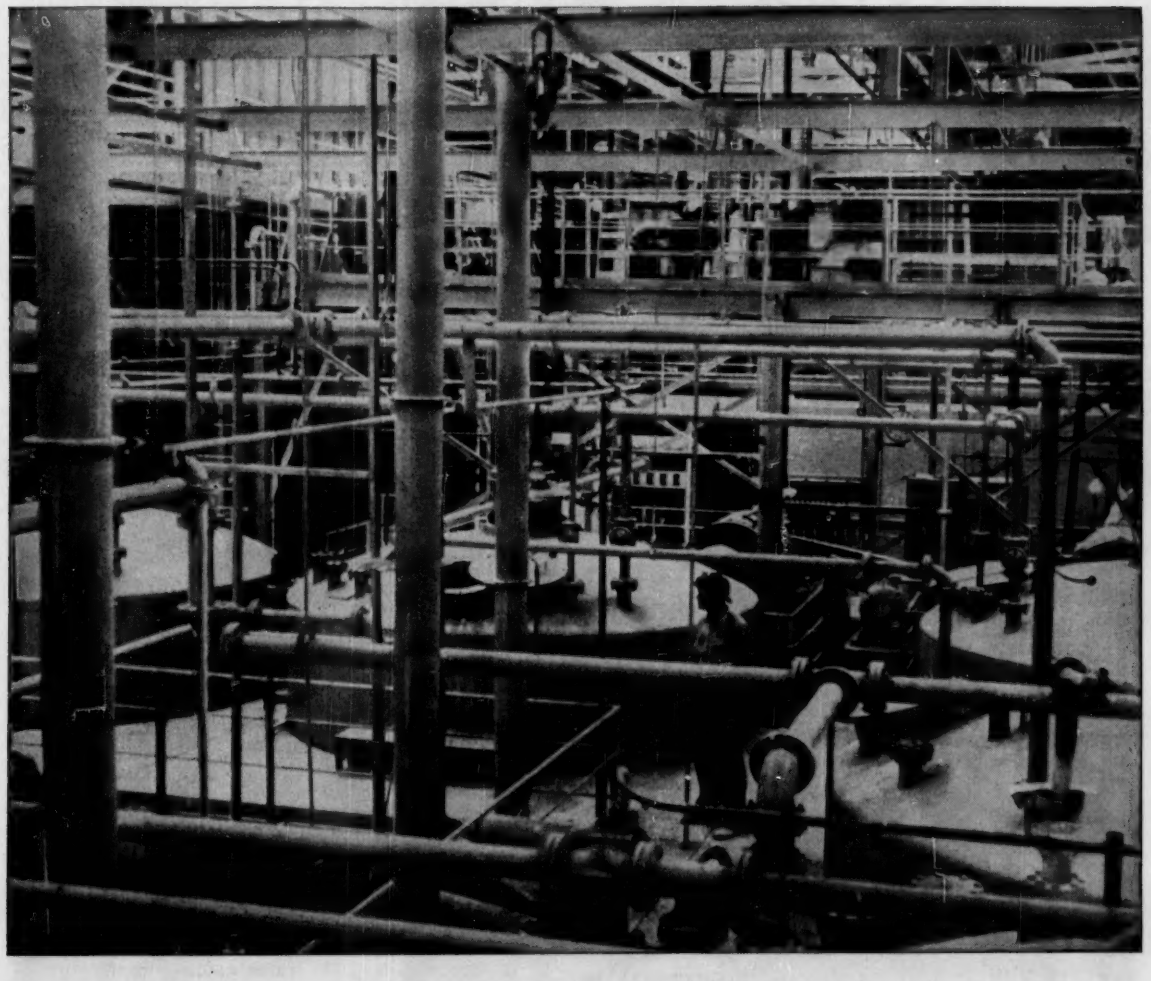
Dry Thread-Sealer

Teflon tape replaces dope on threaded pipe joints.

Pipe fitters can wrap up jobs in a hurry with new Teflon tape, which replaces conventional pastes and compounds for treating thread before a pipe joint is made up.

Called Wrap-It, tape is simply wrapped on threads before pipe

DOW | **SARAN LINED PIPE**



Saran Lined Pipe . . .
process lifeline with a hot acid cargo

When a complex piping system carries corrosive process liquors . . . when it must withstand constant thermal stress imposed by its high-temperature cargo . . . corrosion resistance and high physical strength are the keys to pipeline dependability.

The maze above is of Saran Lined Pipe, and is a part of the process piping at American Cyanamid's Savannah plant, Savannah, Georgia. Most of this pipe carries process liquors with a sulfuric acid content of 25% . . . at temperatures of 165° F. and above. Pumping pressures range upward to a maximum of 70 psig.

The chemical activity and high temperatures of the pipe's contents are severe threats to pipeline durability, but thanks to the extreme corrosion resistance and high strength of Saran Lined Pipe it has performed dependably for American Cyanamid since installation four years ago.

Similar sections of Saran Lined Pipe carry hydrochloric acid in concentrations as high as 37%, while others are used to transfer 10% caustic soda. In many areas other types of corrosion resistant piping have been replaced with new Saran Lined Pipe, with highly satisfactory results.

When processing systems require piping that must resist corrosion and chemical activity, under a wide variety of conditions, consider dependable Saran Lined Pipe. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Department 2280AK9-5.

See "The Dow Hour of Great Mysteries" on TV

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

A BATCH A MINUTE!

PRECISION MIXING

WRITE FOR FREE BULLETIN X-19R

from a few pounds to over 16 tons, with

Daffin MACLELLAN BATCH MIXERS

Used by industries the world over to mix and/or blend a complete batch of dry, free-flowing ingredients in one-minute cycles. Exclusive design prevents material separation or particle breakdown regardless of densities. Fast loading, unloading. Easy to clean.

CAPACITIES: 5 qts. to 160 cu. ft. Hand and motor driven models. All sizes available in stainless steel, other alloys.

Daffin MANUFACTURING COMPANY
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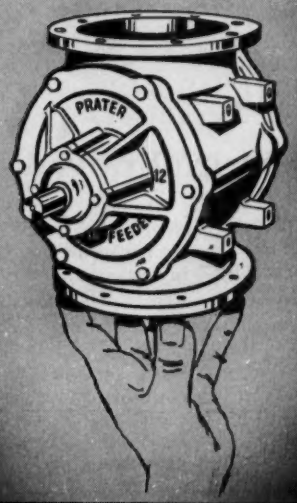
PRATER — *the recognized leader*

ROTARY AIRLOCK FEEDERS

for DUST CONTROL and PNEUMATIC CONVEYING



WRITE FOR BULLETIN P58

PRATER PULVERIZER COMPANY
1517 South 55th Court • Chicago 50, Illinois

is screwed into fitting. Teflon base enables the tape to withstand operating temperatures from —250 to 500 F., makes it chemically inert. Assembly and disassembly is facilitated by self-lubricating properties of the tape.

It is supplied in ten colors, ½-in. wide, in lengths of 25, 50, and 75 yd., is particularly suited for service on corrosive chemical, vacuum and steam lines.— **Hitemp Wires, Inc., Westbury, N. Y.** 182B

Alarm Rotameter

Abnormal high or low flow rates cause signal.

A new alarm rotameter measures fluid rate of flow and indicates when it becomes abnormally high or low. Warning signal can be used to start or stop a pump, motor, or control unit, or simply as an alarm.

Basis for the signal is an extension rod with an encapsulated magnet. Mounted above the meter is a sensing device comprising one or two units mounted on the housing tube.

When flows are within the range desired, the magnet on the extension rod will rise or fall with the float, but will stay between the sensors. When flow is higher or lower, the magnet will pass one of the sensors, thus interrupting a magnetic circuit, which in turn opens or

5 good reasons for specifying Alcoa aluminum electrical rigid conduit

Saves installation labor. ompare the 34-pound weight a 10-foot length of 4-inch uminum conduit with the 3 pounds of the same size in eel. This weight advantage ys off handsomely in all nases of handling. And, Al- a aluminum conduit is eas- r to cut, thread and bend.

2. Appearance. With aluminum conduit you can forget staining of adjacent surfaces. Under normal conditions, there's no painting needed, because aluminum's natural good appearance is inherent.

3. Resists corrosion. This seamless extruded conduit stands up to most corrosive environments. It requires no galvanizing or other protective coating. Even in food processing plants it needs no paint.

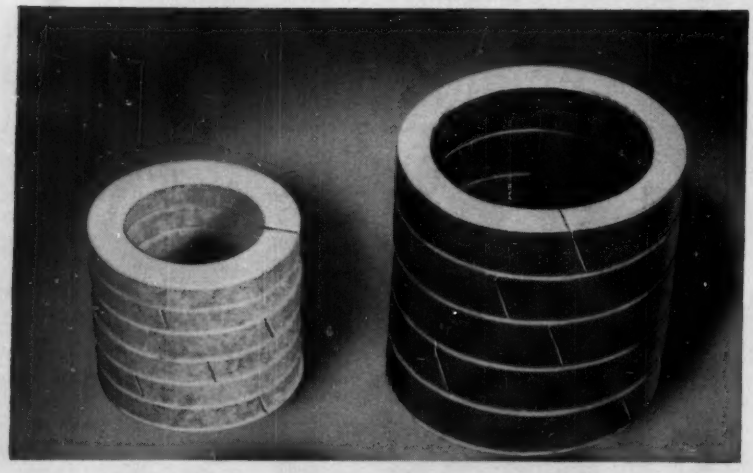
4. Electrical advantage. Aluminum's low impedance, due to its nonmagnetic characteristic, coupled with its high electrical conductivity provides greater protection against ground-fault hazards. Phases may be separated and run in individual nonmagnetic aluminum conduit.

5. **Over-all costs.** Compare first cost of Alcoa aluminum conduit with steel conduit. Then consider the installation and maintenance savings, and the long range value of aluminum really shows to advantage.

et all the facts and figures in time for your ext job. Contact your electrical distributor or one f our representatives. Or drop us a line for free terature. Write to Rome Cable Division of Alcoa, ept. 7-80, Rome, New York.

ROME CABLE
DIVISION OF **ALCOA**

STILL THE No. 1 TEFLON* SHAFT PACKING FOR PUMPING CORROSIVES



...CHEMPRO STYLES 101 and 201

(THE ORIGINAL TEFLON SHAFT PACKING)

Chempro Styles 101 and 201 Teflon Shaft Packings, although developed and perfected over 10 years ago, are still the most popular Teflon shaft packings for pumps handling highly corrosive products.

These two stuffing box packings drastically cut packing replacement and maintenance costs. Styles 101 and 201 last for months under corrosive conditions where ordinary packings fail in days and even hours. Successfully seals against bromine, chlorine, butyl extracts, sulphur dioxides, concentrated sulphuric acid, aqua regia, thionyl chloride and organic solvents including halogenated hydrocarbons, etc.

Ideal for use on either centrifugal or reciprocating pumps, at speeds up to 3600 R.P.M. and at temperatures ranging from —118°F. to +525°F.

STYLE No. 101 — Compounded of approximately 94% shredded Teflon and a graphite friction reducer, molded into packing rings.

STYLE No. 201 — Same as No. 101 except that mica is used as the friction reducer.

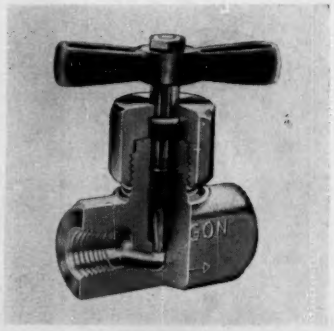
Both styles are made in sizes to fit any stuffing box. Supplied in ring sets for specific equipment or in single quantity ring orders.

Write for Chempro Bulletin CP 552.

*duPont Trademark

CHEMICAL & POWER PRODUCTS, INC.
5 Broadway, New York 4, N. Y.
The Original Fabricators of Teflon Packings and Gaskets

closes the alarm circuit. — **Schutte & Koerting Co., Cornwells Heights, Pa.** 184A

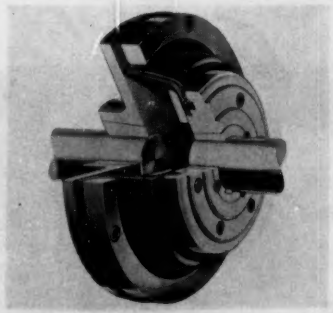


High-Pressure Valve

Stem can't blow or back out under pressure.

Operate a new high-pressure valve without fear. Rated to 10,000 psi., the valve body contains integral neck threads. The stainless steel stem, protruding through a separate nut, is held in place by both nut and integral threads, can't blow out.

Designed with a 4:1 safety factor, the valve has a Teflon back-up ring which prevents dirt or contamination from getting inside via the stem opening.—**Dragon Engineering Co., Norwalk, Calif.** 186A



Flexible Coupling

Rubber element absorbs misalignment and shock.

Shaft alignments need not be precise with new coupling fea-

BRIEFS

benzoic acid
chlorotoluenes
lauryl pyridinium chloride

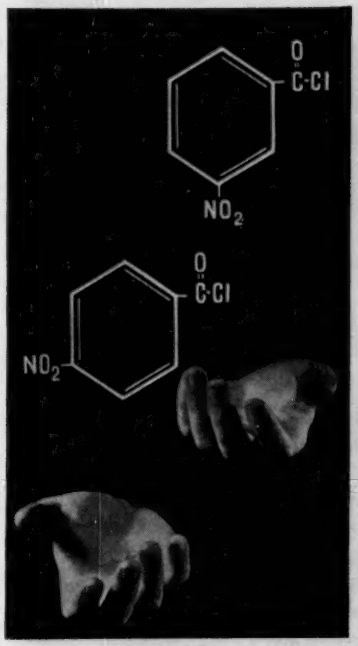
THE DIFFERENCE IS HALF A PERCENTAGE POINT

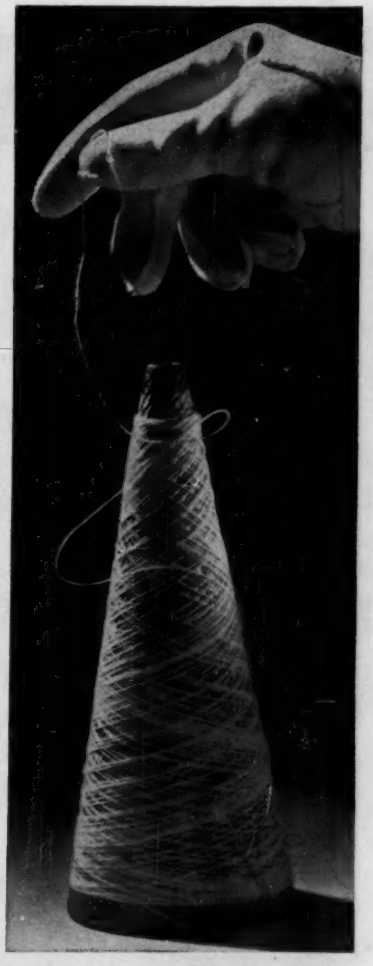
Only .5% difference in assay distinguishes the technical and USP grades of Hooker benzoic acid. Both are available as a white powder or in crystalline form. The technical grade finds use as a dyeing assistant, especially for materials such as Dacron; as a flatting agent for paints and as a rubber retarder. The USP grade finds use as a preservative in antiseptic preparations and in cosmetics and some other products. Write for our new data sheet.

ISOMERIC FLIP-FLOP

Among the chlorotoluenes is one called nitrobenzoyl chloride. Hooker makes it. Its *meta* isomer (diagram) goes to the dye industry as an intermediate, and to the photographic film industry for use in preparation of the dyes that make crisp, sharp color prints so practical.

When you flip the NO_2 to the *para* position (diagram), you get a product used for preparation of procaine which, added to penicillin, lengthens the effective period of dosages. Hooker can provide both isomers. The *meta-* assays 96% min., while the *para-* assays 98% min. Write for data sheets.





CATIONIC DETERGENT

Hooker lauryl pyridinium chloride, having a minimum assay of 85%, is sold as an unrefined technical material. Like most quaternary ammonium compounds, it has potent bactericidal properties. But its primary use is as a cationic agent in viscose rayon to prevent clogging of spinneret orifices. Other possible applications: dispersing and wetting agent; water-soluble lubricant additive for textile machinery; intermediate in manufacture of foam-resistant compounds; leveling agent in polishes and waxes. Write for data sheet.

For more information, check here and mail with name, title and company address:

- ☐ Benzoic acid, Data sheet
- ☐ Lauryl pyridinium chloride, Data sheet
- ☐ *meta*-nitrobenzoyl chloride, Data sheet
- ☐ *para*-nitrobenzoyl chloride, Data sheet

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Sales Offices: Buffalo Chicago Detroit Los Angeles New York Niagara Falls Philadelphia Tacoma Worcester, Mass.
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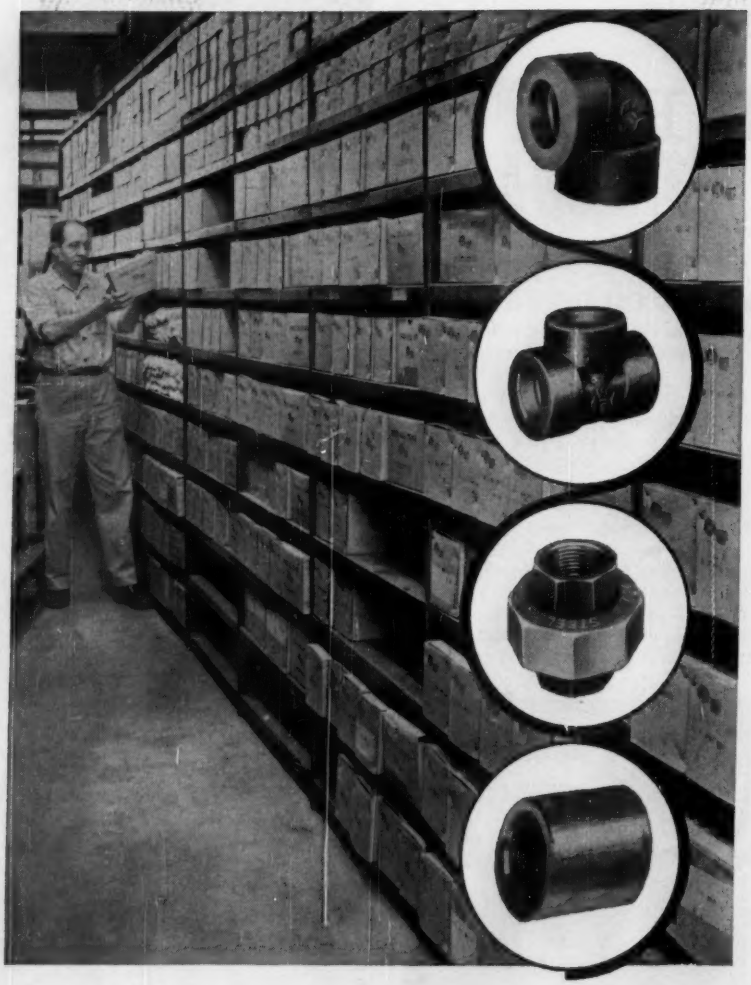

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PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

turing a pan-shaped rubber flexing element. Whether the misalignment is angular or parallel, the coupling will still transmit power without vibration.

Known as Para-flex, it also absorbs end float and torsional vibration. One side of the flexible member is supported by a clamp-ring flange. The other end is bolted to a steel disk.

Designed for speeds up to 5,230 rpm., the coupling may be used with electric motors or internal combustion engines. The rubber element acts as an insulator between motor and driven equipment, prevents current flow between shafts. — **Dodge Mfg. Corp., Mishawaka, Ind.** **186B**

BRIEFS

Portable infrared heater, Model 96-848, has casters on the base for easy moving. Wide-angle gold-plated reflectors handle up to a 24-kw. load. Top sections are adjustable so unit can conform to product contours.—**Fostoria Corp., Fostoria, Ohio.** **188A**

Unicon, acid corrosion inhibitor, can be added to any concentration of HCl to permit any metal to be cleaned by immersion. Inhibitor protects metal surface while acid cleans off scale, rust, etc.—**Developments Unlimited Inc., Passaic, N. J.** **188B**

Audible reports of flow meter readings in pipeline systems are given by Data, a new device which can use almost any transmitting medium. In a typical application, operator dials a telephone, hears report of meter reading.—**Continental Technical Service, Inc., Dayton, Ohio.** **188C**

Ultra-high vacuum, cold-cathode ionization gage indicates pressures down to the 10^{-14} mm. Hg range. Dubbed Redhead, it measures pressure in terms of a very small current that is produced when gas molecules are ionized and at-

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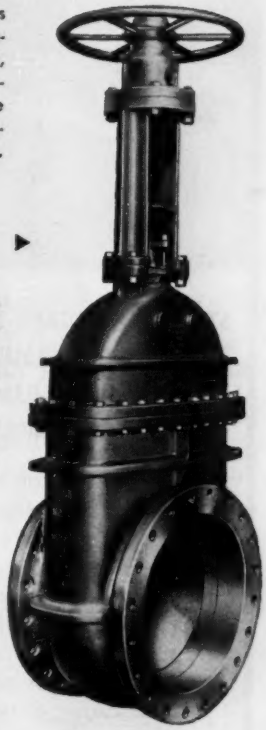
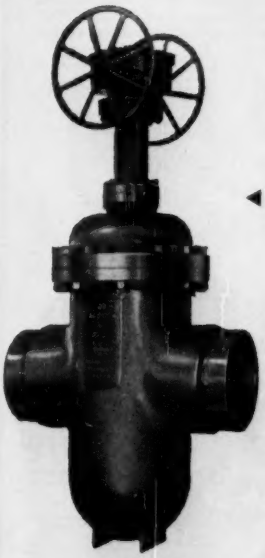
—featuring all the advantages of the above revolving disc principle, *plus* new economies in the handling of "problem" fluids and gases or wherever aluminum piping is used. Ask for Bulletin SLS 5801.





◀ DARLING-McEVOY SELF-SEALING CONDUIT VALVES

— the *only* conduit gate valve with *sealant gasketing* between gates and seats. Every closure leakproof! This and other advantages proved by outstanding performance on major lines. Get *all* the facts. Ask for Catalog 57.

Whatever the service, in any phase of pipelining, gathering or processing, these Darling gate valves offer worthwhile features and advantages unobtainable in other valves. The catalogs referred to above are available to give you the pertinent facts.

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Manufactured in Canada by
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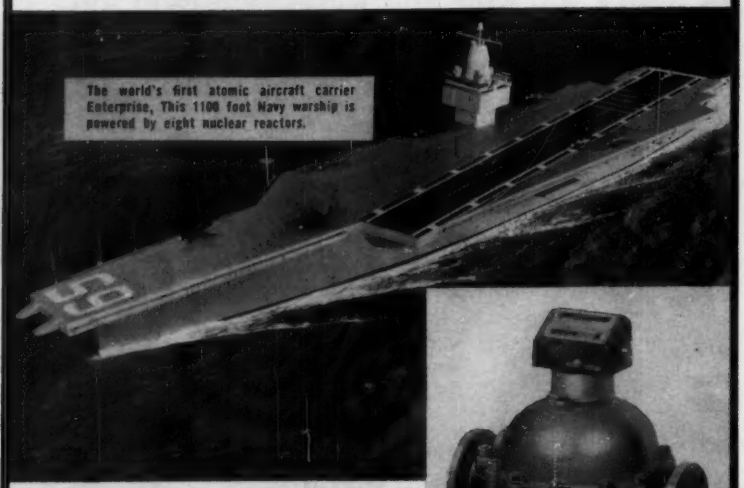
NIAGARA METERS

Meet the Exacting Requirements of Nuclear-Powered Ships



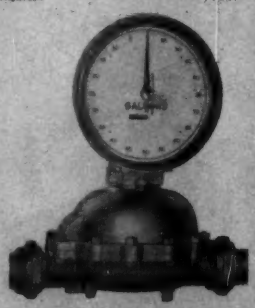
STANDARD NIAGARA METERS MEASURE DEMINERALIZED COOLING WATER WITHOUT DANGER OF CONTAMINATION

To reduce radioactive contamination in U.S. nuclear-powered ships, the cooling water for the nuclear reactor is demineralized. After demineralizing, the pure water must be measured. The meter selected for this operation must not recontaminate the water and make it a potential carrier of radioactivity.

Niagara Chemical Meters with stainless steel casings were selected. These are standard meters, the same as offered to the chemical industry for metering corrosive liquids. They met the critical Navy requirements without change, to meter and maintain the purity of the cooling water.

The complete line of Niagara Meters is described and illustrated in Bulletin 43. Send for your free copy.

Niagara Stainless Steel Meter. The same as used on the Enterprise. Used industrially for accurately measuring corrosive liquids.



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Niagara High Pressure Meter. Extra heavy, for measuring liquids at high pressure.

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NEW EQUIPMENT . . .

tracted to a collector.—**NRC Equipment Corp., Newton, Mass.** 188D

Mount new dissolver on upper floors, walkways, balconies—It's designed for 'through-the-floor" operation to save space. Unit has hydraulic lift mechanism that allows cylinder to operate through the floor, provides 48-in. rise of the mixing mechanism to clear tanks. — **Morehouse-Cowles, Inc., Los Angeles.** 190A

Fractionator control system irons out column upsets by fast regulation of external reflux flow. It computes internal reflux flow from measurement of external flow and temperature difference between overhead product and external reflux, regulates valve to give constant internal reflux flow. — **Crane Co., Manchester, N. H.** 190B

Fluorescent danger flags, brilliant flame red, are made of vinyl, permanently bonded to both sides of nylon base fabric. Available in assorted styles and sizes.—**A. W. Pendergast Safety Equipment Co., Philadelphia.** 190C

Equipment Cost Indexes . . .

	Mar. 1960	June 1960
Industry		
Avg. of all	237.8	238.2
Process Industries		
Cement mfg.	232.4	232.8
Chemical	240.0	240.1
Clay products	225.8	226.2
Glass mfg.	226.6	226.6
Paint mfg.	229.7	229.8
Paper mfg.	231.3	231.3
Petroleum ind.	234.7	234.1
Rubber ind.	237.5	237.6
Process ind. avg.	236.3	236.5
Related Industries		
Elec. power equip.	242.8	242.7
Mining, milling	241.5	241.5
Refrigerating	268.4	268.5
Steam power	224.9	225.0

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; April 4, 1960, pp. 149-50 for annual averages since 1913.

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CASTERS & WHEELS
have all these advantages

1 RUBBER TREADS

. . . a wide choice of treads suited to all types of floors, including Darnelloprene oil, water and chemical-resistant treads, make Darnell Casters and Wheels highly adapted to rough usage.

2 RUST-PROOFED

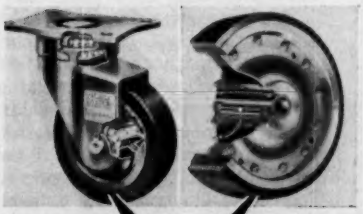
by zinc plating. Darnell Casters give longer, care-free life wherever water, steam and corroding chemicals are freely used.

3 STRING GUARDS

. . . Even though string and ravelings may wind around the hub, these string guards insure easy rolling at all times.

4 LUBRICATION

. . . all swivel and whee bearings are factory packed with a high quality grease that "stands up" under attack by heat and water. Zerk fittings are provided for quick grease-gun lubrication.



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Look in the Yellow Pages for your Darnell Distributor under "Casters".

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SOLKA-FLOC® . . . the unique filter aid. This virtually 100% pure, finely divided cellulose is providing important answers for improved filtration and processing in many industries. Not only is SOLKA-FLOC supremely efficient in *adsorbing* many metals such as iron, copper, and other impurities—its greater efficiency saves time and money.

Whether your field is heavy chemicals, food processing, pharmaceuticals, chromatography, beverages, textiles, plastics, water purification or many other areas . . . SOLKA-FLOC may provide the better, more economical way.

We would like to show you how it improves filtration flow rates . . . keeps screens cleaner . . . saves down time . . . gives more volume of clarified filtrate with minimum retention in cake . . . how it makes a stable pre-coat, does not bleed . . . prevents loss of cake from pressure drops . . . and why it does not abrade pumps and valves. Just write us about your specific filtration problem and we will be glad to send you experimental samples and provide answers . . . no obligation.

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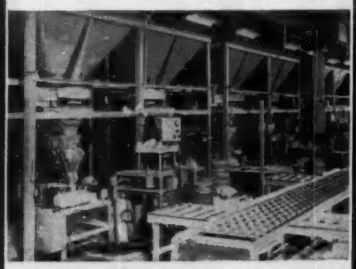
PROBLEM:

MAINTAIN UNIFORM GRAIN SIZE IN PRODUCTION OF RESIN-BONDED ABRASIVE WHEELS



SOLUTION:

SPROUT-WALDRON GYRO-PEDESTAL® SIFTERS

The pressure sensitive nature of the resin bonded granules used to make quality abrasive wheels at Carborundum, led to the formation of oversized agglomerates. These had to be screened out or broken up in order to maintain uniform grain size.

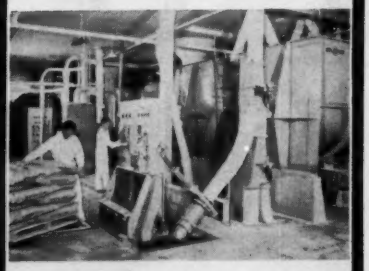
The problem was compounded by the fact that the resin bonded mixture had to be kept in surge bins at the 86 molding stations.

The use of 43 Sprout-Waldron Gyro Pedestal sifters, installed so that each sifter could serve two surge hoppers, solved the problem. The high speed gyratory action of these sifters breaks up the agglomerates and discharges a stream of uniform, correctly sized free flowing granules into the mold.

For more data on the Gyro Pedestal sifter ask for Bulletin 139.

PROBLEM:

TO BOOST STARCH AND GUM PRODUCTION WHILE CUTTING OPERATING COSTS



SOLUTION:

SPROUT-WALDRON UNIT MACHINES AND SYSTEMS

When Morningstar Paisley executives decided to move activities to their new plant at Hawthorne, N. J., they demanded a system meeting these specifications: extreme versatility, no dust nuisance, protection against contamination, low handling and operating costs, stepped up capacity.

The answer was found in a packaged processing system involving Sprout-Waldron machinery for crushing, mixing, grinding and sifting; plus a series of four negative pressure pneumatic conveying systems.

Blending and bagging of starch, gum grinding and gum granulation are now being accomplished with a minimum of handling and maximum of efficiency. Operating costs are down, capacity up. For the full story ask for Bulletin F-19.

S W SINCE 1866

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Size Reduction • Size Classification • Mixing and Blending
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Technical Bookshelf

Challenge

INTRODUCTION TO MATRIX ANALYSIS. By Richard Bellman. McGraw-Hill Book Co., New York. 328 pages. $10.

Reviewed by James I. Morgan, St. Regis Paper Co., New York, N. Y.

Level of this book is slightly above that of most undergraduate texts of matrix algebra. Its approach is different and more challenging. Rather than stating a number of principles, the author guides the reader through a logical pattern where the principles are introduced as needed.

It's the first of a series of at least four and undoubtedly more volumes on matrix theory. Others by different authors will follow on computational treatment of matrices, combinatorial theory of matrices, and topological aspects. This one is designed to cover only the fundamental concepts. It is divided into three sections: the theory of symmetric matrices, matrices and differential equations, and positive matrices.

The book illustrates the applications of matrix analysis to a wide range of mathematics; consequently, it is necessarily brief in its presentations. The bibliography, however, is outstanding since the author uses it for comments and to give references for those interested in further study.

Engineers who already have an acquaintance with various fields of higher mathematics will find this book valuable in increasing their proficiency in these fields.

An engineer without this acquaintance may find parts of the book difficult because there are few ideas illustrated by numerical examples and because most of the exercises are proofs. The principal value of this book to him will be as a supplement to his other studies in higher mathematics.

Soft-Cover Septet

Seven additions have been made to the softbound section of CE's Technical Bookshelf. All attractively priced, they include

four volumes in Doubleday Anchor's Science Study Series and a trio from Harper Torchbooks' Science Library.

Doubleday's offerings:

(1) *The Restless* Atom. By Alfred Romer. 198 pages, 95¢. A potpourri of atomic experiments made in the two decades prior to World War I. The work of Rutherford, Bohr, Rontgen, the Curies, et al.

(2) *The Birth of a New Physics.* By I. Bernard Cohen. 200 pages, 95¢. Physics history. The scientific trails blazed by Copernicus, Galileo, Kepler. Full focus is put on Newton's contributions.

(3) *Crystals and Crystal Growing.* By Alan Holden and Phylis Singer. 320 pages, $1.45. Spacious treatment of the subject. Includes tempting "recipes" for home-growing.

(4) *The Neutron Story.* By Donald J. Hughes. 158 pages, 95¢. A journey to the subatomic world. The nature and exploits of neutrons.

The Harper arrivals:

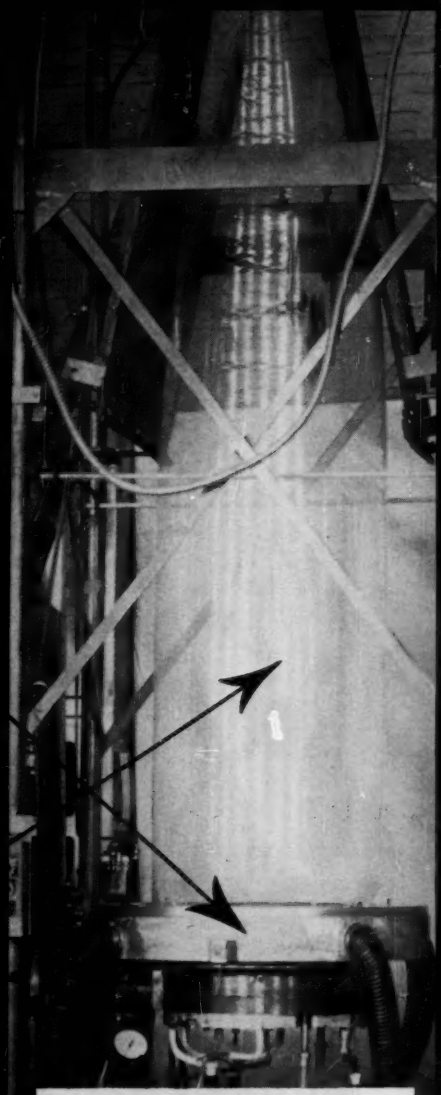
(1) *Chemistry in the Service of Man.* By Alexander Findlay. 8th ed. 318 pages, $1.75. Latest edition includes new material on drugs and antibiotics, insecticides, artificial fibers, vitamins and hormones, nuclear energy, also gives an accounting of recent developments in metals.

(2) *A Short History of Chemistry.* By J. R. Partington. 3rd ed. 415 pages, $1.95. New edition of this well-known work features revised sections on Mayow and Lavoisier, includes discussion of the modern treatment of valency, and is fully illustrated.

(3) *A Direct Entry to Organic Chemistry.* By John Read. 268 pages, $1.50. Assuming "no previous knowledge of chemistry on the part of the reader," book is intended for the layman, also for students who have "stopped short of the threshold of organic chemistry."—HSG

Blown Film

COOLING CAPACITY



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Air Ring performance here . . .

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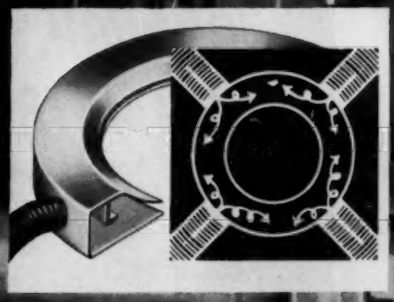
provides faster "bubble" cooling for higher production speeds . . .



Exclusive D-S Velocity Control Air Ring

design prevents lopsided air distribution. Internal baffles provide "engineered turbulence" to evenly distribute air flow around entire circumference of die.

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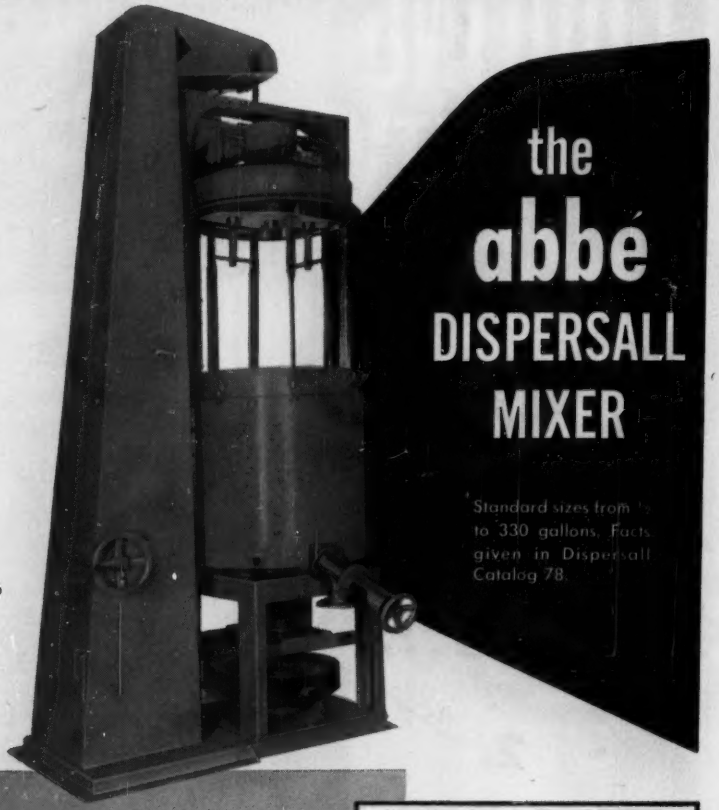
LIQUIDS, SLURRIES, PASTES



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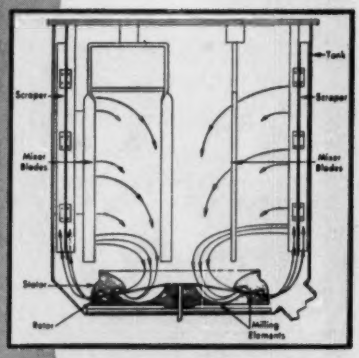
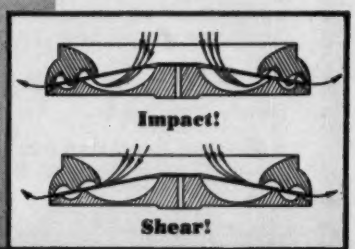
Standard sizes from ½ to 330 gallons. Facts given in Dispersall Catalog 78.

FAST, THOROUGH, COMPLETE ACTION!



... BLENDS
DISPERSES
EMULSIFIES
DISSOLVES
MIXES



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Letters: Pro & Con

Pro & Con: Fluid Flow

Sir:

This letter refers to the Ludwig article in your June 13 issue, specifically to the table on p. 202 on materials of construction for centrifugal pumps.

Sulfuric acid, when handled in cast iron pumps, "creeps," covering the outside of the pump, where it absorbs moisture from the air and becomes diluted and thus corrosive to iron. I have seen iron sulfate corrosion product on the outsides and base plates of iron pumps so used by those hoping to save money by not buying the proper pump.

High-silicon iron is subject to mechanical and thermal shock. There is a case on record where a man was killed when the descending column of sulfuric acid broke such a pump when the pump motor was suddenly shut off. The discharge line was vertical—straight up from the pump.

In pumping NaOH where pickup of small amounts of Fe is objectionable, nickel pumps are fine, but they are not generally kept in stock for quick shipment. A good super-stainless austenitic steel with 20% Cr, 24% Ni and 48% Fe will show no Fe pickup when handling 50% and 73% NaOH at 250 F. Such pumps are stock items and are ready to ship after assembly with suitable drivers.

Some river waters near by-product plants and oceans have been known to graphitize some iron casings, causing the casing to become cathodic to the bronze impeller, thus accelerating corrosion of the pump interior.

My point is that correct pump selections are rarely made by the user. Let the pump manufacturer, his duly authorized representative or dealer make the selection.

FREDERICK WAITE
Worthington Corp.
Newark, N. J.

▶ *While we don't necessarily endorse Mr. Waite's conclusion, we agree that proper selection of pump*

materials cannot be based entirely on the general kind of information published in Mr. Ludwig's Table XI.—ED.

Sir:

Mr. Ludwig's article in your June 13 issue (pp. 161-208) is one of the more useful and concise practical design guides I have seen.

There are, however, some ambiguities in the nomenclature which could lead to erroneous calculations. For instance, in Eq. 26 (p. 177) for calculating the size of an orifice installed in a steam line to limit steam flow, s should be expressed as a decimal, rather than a percentage as stated in the nomenclature. It might also be helpful to indicate that P refers to the upstream pressure.

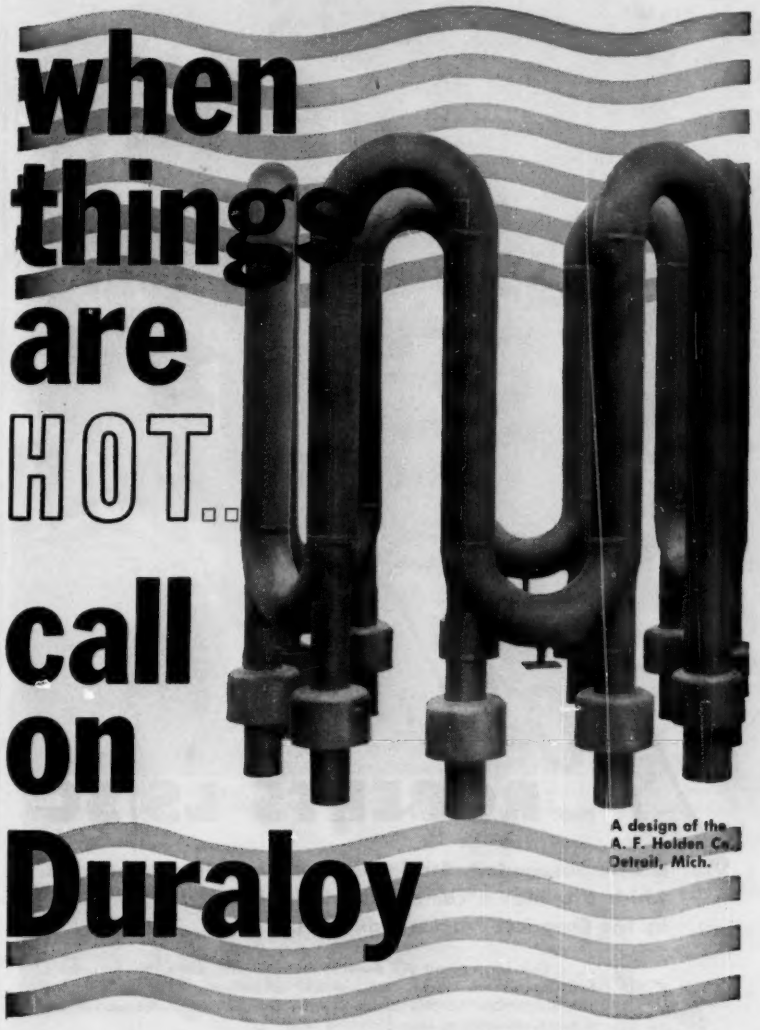
H. SENZ
Rhodia Inc.
New Brunswick, N. J.

Sir:

My compliments to Mr. Ludwig for his article on "Flow of Fluids" in your June 13 issue. It is a fine job. I only wish it were "perfect," especially since you indicate that this material is to be published in book form.

Some of the errors are quite obvious:

- Fig. 31, p. 190—If head and capacity are the same for three different types of pumps, then horsepower must vary with efficiency.
- Fig. 35, p. 192—Legend at lower left states maximum impeller diameter is 6 in.; curve shows 6½ in.
- Fig. 46, p. 201—Efficiency of 73% is not obtainable in such a small pump. Again, horsepower does not check with efficiency. Also, the maximum horsepower is not realistic for the design brake horsepower given.
- Fig. 50, p. 205—This illustration shows a plain, old-fashioned, duplex piston pump. Why not show a modern pump? One of the biggest demands in pumps today is for horizontal triplex



Castings that Keep their Load-Carrying Strength at High Temperatures

This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY... our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.

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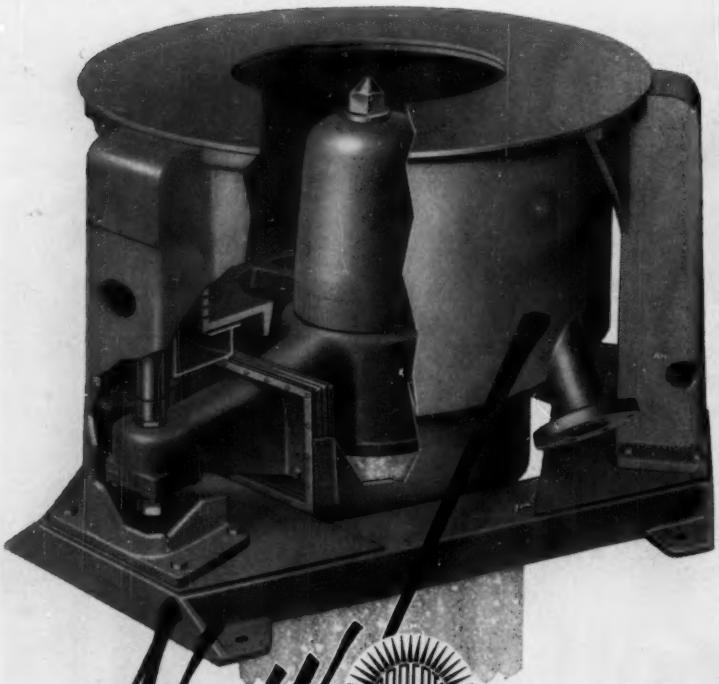

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a Link Suspended, Stationary Curb centrifugal machine which provides a combination of features long wanted by the Chemical Process Industries.

Features . . . Link Suspension! No metal to metal moving parts. No lubrication. Soft lateral movement. No vertical movement. Effective damping. This suspension isolates dynamic parts from curb and foundation and reduces vibration to an astonishing low.

Features . . . Stationary Curb! With rigid feed, wash, effluent, and solids-discharge connections. No vibration damage to curb mounted accessories. Extends bearing life by reducing bearing loads. Increases personnel safety. Provides rapid drainage, more effluent capacity.

Features . . . Direct Coupled Hydraulic Motor! No belts. Compact. Light weight. Provides power for exclusive, slow speed, reverse discharging. Provides adjustable loading speed and adjustable top speed. Hydraulic braking (even at power failure). No brake linings to wear. Constant horsepower drive reduces peak electric loads.

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plunger pumps. This is a pump that the average chemical engineer doesn't even understand; yet he is called upon to select and write specifications for such pumps.

One other matter is the difficulty of making reference to information given in the so-called Standards of the Hydraulic Institute. This is shown on p. 207, giving selected recommended piston speeds. If you tried to operate a 6-in.-stroke pump at the recommended 59 ft./min. (or 118 single strokes per min.), you would have a most unsatisfactory operation. A piston speed nearer 30-35 single strokes per min. would be more realistic. This is because normally you do not have unlimited NPSH, and a pump operating above 35 strokes per min. is likely to require more NPSH that can be expected in the average plant.

In other words, to divorce piston speed from NPSH is not doing justice to the pumps. It's small wonder that many operators are discouraged with the use of reciprocating pumps; the poor pumps just don't have a chance.

PAUL L. ARMSTRONG
Sales Engineer
Los Angeles, Calif.

▶ *Author Ludwig has called attention to the fact that in Fig. 42 (p. 197) we should have transposed the system curves for new and "aged" pipe.*—ED.

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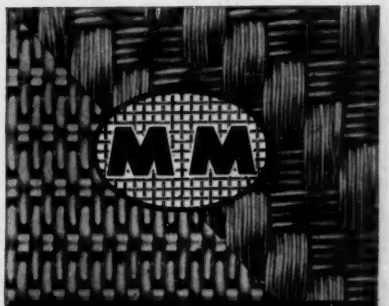

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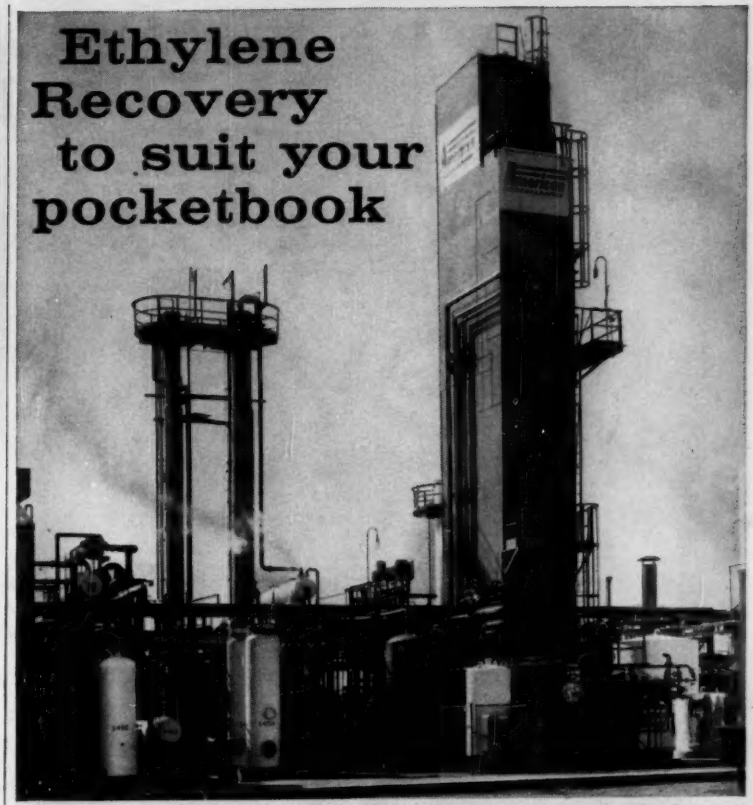

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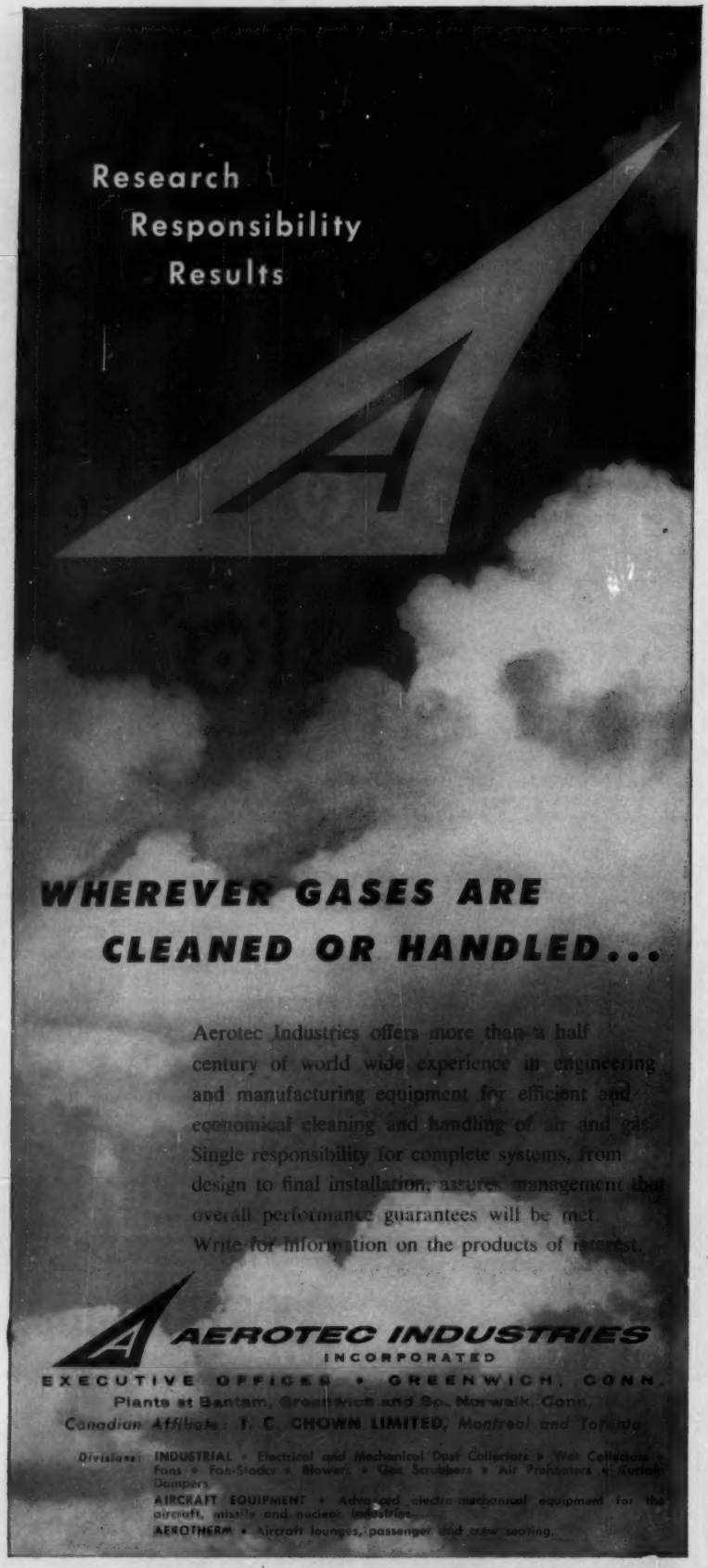
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virtual alphabet soup of organizations—AIChE, ASME, AACE, ACS, NSPE and others. For example:

• *CE* editors are now serving on these national AIChE committees—Admissions, Chemical Engineering Education Projects, Program, Public Relations—and have served previously on other committees, such as Career Guidance, Professional Development, Sections Activities, Symbols and Nomenclature. Other editors serve on national committees of ASME, AACE, etc.

• When national AIChE meetings come to New York, Houston or San Francisco, *CE* editors are working behind the scenes. One of the big jobs ahead (expected attendance: 3,000) will be the annual meeting in New York in December 1961. Three of the major committees already organized for this meeting will be headed by editors of *CE*. Another *CE* editor has planned several program sessions for this year's ASME meeting in New York.

• American Assn. of Cost Engineers and AIChE's Heat Transfer Div. entrust their treasuries to the care of *CE* editors.

• Many of our editors carry over their fluency in writing into the public speaking field. Audiences have been various engineering groups—AIChE, ACS, AACE, NSPE, ASEE—as well as service clubs and student groups.

This rundown of activities would range still wider if we listed, in addition, the services our editors have rendered to professional organizations at the local level. Nor have we included the far-flung activities of such staff alumni as Sid Kirkpatrick and Jim Lee, recently retired, and John Callaham, now in a management post here at McGraw-Hill.

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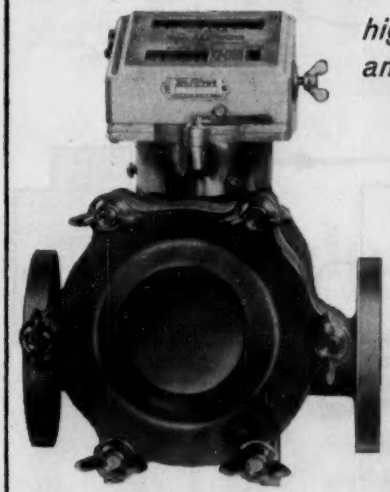

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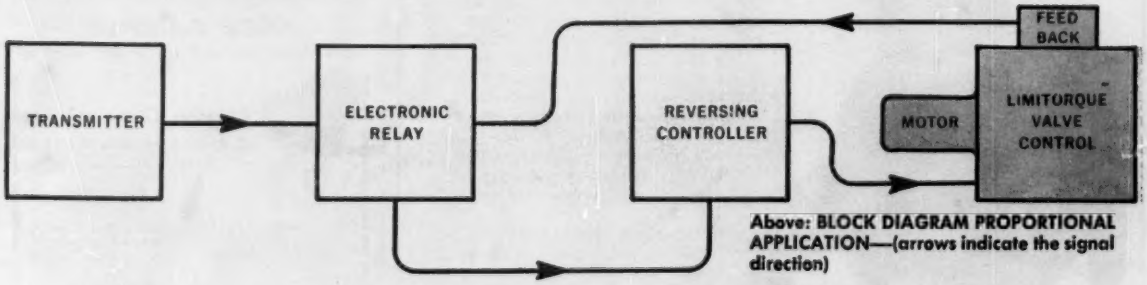

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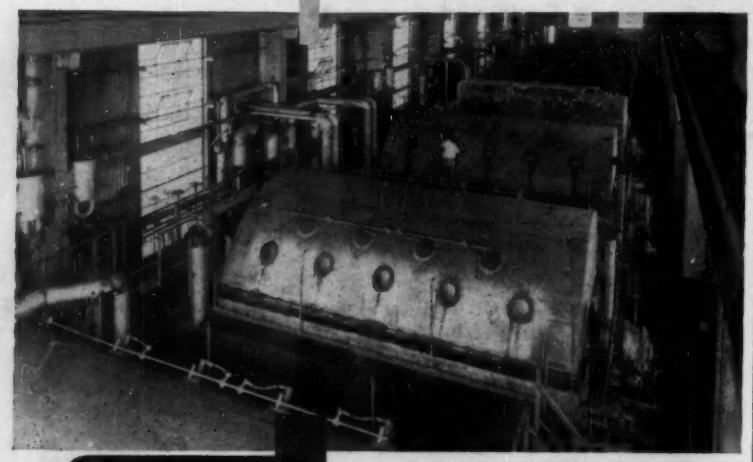
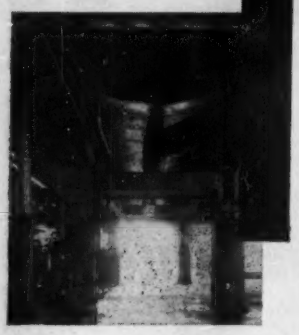
the problem: low oil content quality wax on a HIGH PRODUCTION BASIS



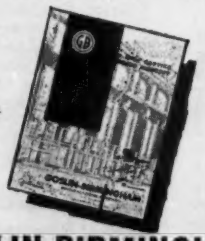
ROTARY DRUM FILTERS HANDLE THE JOB... EFFICIENTLY!



High efficiency is obtained with this G-B filter system for Mobil Oil Company at its Beaumont, Texas Refinery. These units feature a self-contained variable speed drive, efficient modern lighting and sight glasses, 2" and 3" FOAMGLAS insulation for low temperature operation. Fine quality parrafin wax of low oil content is obtained on a high production basis.

G-B filters are customed designed to meet your specific need. Write for more detailed information.

See our insert in Refinery Catalog and CEC.



GOSLIN-BIRMINGHAM
MANUFACTURING CO., INC.
P. O. BOX 631 BIRMINGHAM, ALABAMA
FILTERS • EVAPORATORS • PROCESS EQUIPMENT • CONTRACT MANUFACTURING including HEAVY CASTINGS

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Chemicals

Activated Carbon.....is the most versatile liquid and gas purifier. All types are manufactured. Literature J-103 is available for more information.
233R *Barnebey-Cheney

Algin.....The title of this bulletin, "Emulsifying, Thickening, Suspending and Stabilizing with Algin" is self-explanatory concerning its contents and slant.
204a Kelco Company

Alumina....Calcined alumina in grades KC-1 and KC-2 for manufacture of high-grade abrasives, refractories and ceramics. Grades KC-10 and KC-14 for wide range. Brochure.
173 *Kaiser Chemicals

Benzoic Acid.....Technical and USP grades of Hooker benzoic acid. Both available as a white powder or crystalline form. New data sheet available on request.
187a *Hooker Chemical Corp.

Bromine.....Over 100 brominated compounds produced, with new ones constantly under study. Complete information on the potentials of bromine in many applications.
33 *The Dow Chemical Co.

Cerium Oxide.....The brochure, "Cerium Oxide for Glass Polishing," describes rare earth processing, polishing-oxide evaluation and several theories on glass polishing.
204b Vitro Chemical Co.

Chemical.....New liquid Triosul ends vaporizer "clean-out" headaches and reduces contamination hazards. Bulletin 1-178 is available for more information.
67 *Monsanto Chemical Co.

Chemicals.....A comprehensive list of over 4,000 laboratory chemicals are presented in a catalog. Includes well-known organic chemicals and hundreds of organics.
204c Matheson Coleman & Bell

* From advertisement, this issue

Chemicals.....Basic chemicals obtainable from ten strategically placed plants. Further information, contained in Reilly Chemical Index, available on request.
73 *Reilly Tar & Chemical Corp.

Chemicals.....More than thirty industrial chemicals, among them ally alcohol, allyl chloride, acetone, bisphenol A, epichlorohydrin, glycerine, etc. General catalog.
Cover *Shell Chemical Co.

Compressed Gases.....A new 46-page booklet describes in detail the compressed gases, gas mixtures, gas controls, and accessories for handling gas.
205a The Matheson Co., Inc.

Cyclohexanone.....A reprint of an article, "Something New For Old Recips," by Lt. Colonel R. L. Selman of the Air Force is offered for lubricating oil additive advice.
205b Allied Chemical Corp.

Dispersant.....Marasperse samples and Information File No. E-90 are available. The simple laboratory screening tests are described in the literature offered.
177 *Marathon Div. of American Can

Elastomer.....New Fluorel brand is a highly fluorinated synthetic rubber that successfully resists corrosive chemicals, fuels, solvents & ozone. Data.
143 *Minnesota Mining & Mfg. Co.

Filter Aid.....Solka-Floc the new filter aid, gives more volume of clarified filtrate with minimum of retention in cake. Solka-Floc Fact Folder offered.
R191 *Brown Co.

Food Additive.....Calcium chelate of disodium ethylenediaminetetraacetic acid, by name, has been recently cleared by the FDA and is described in literature from company.
205c Dow Chemical Co.

Lauryl Pyridinium Chloride.....Minimum assay of 85%. Sold as unrefined technical material. Used as cationic agent in viscose rayon to prevent clogging. Data sheet.
187b *Hooker Chemical Corp.

* From advertisement, this issue

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

It's easy — simply circle item's number on the Reader Service Postcard and mail. Replies will come directly from companies offering the literature.

*FIRST LINE

Extended-Surface

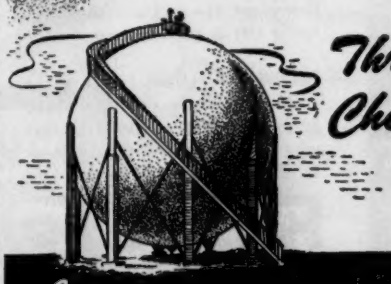
HEAT EXCHANGERS

ASK THE AEROFIN MAN

Specify Aerofin and you specify high efficiency, long service life and low maintenance and service costs.

Take advantage of Aerofin's unequalled experience, production facilities, and materials-testing and design research — of Aerofin's complete engineering service at the plant and in the field.

* *Aerofin makes extended heat surface exclusively — not as a by-product, not as a side-line.*

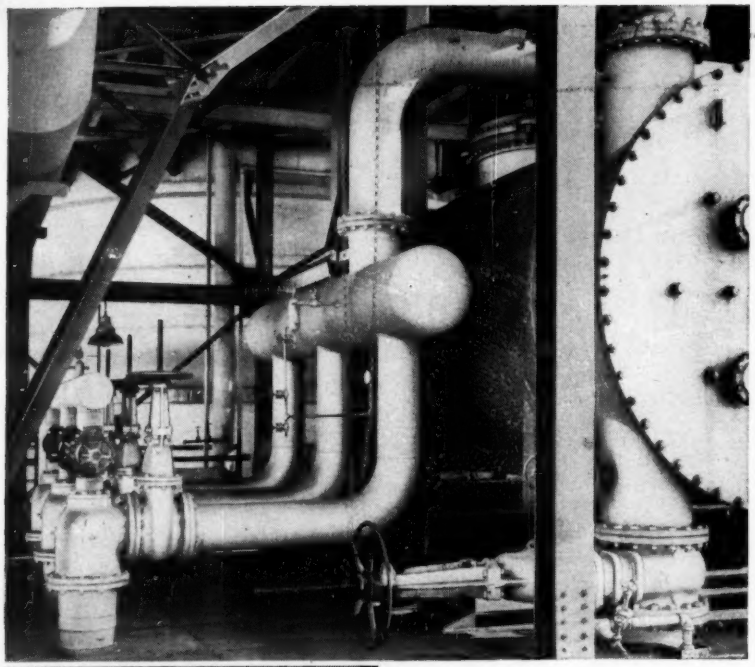


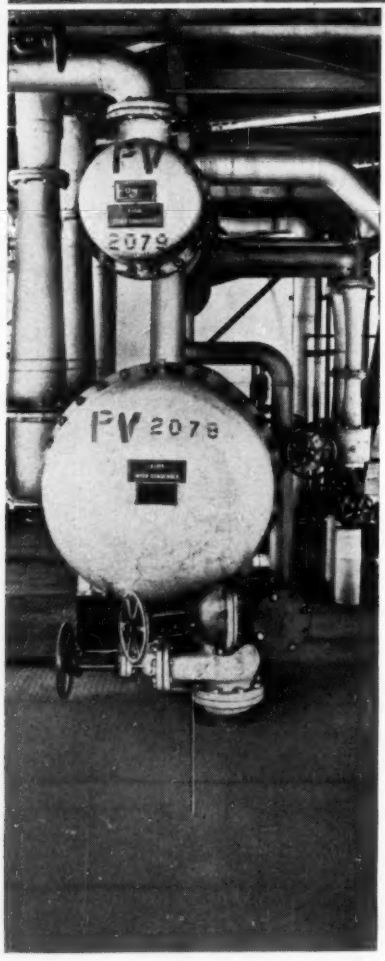
Throughout the Chemical Industry —

Aerofin units do the job Better, Faster, Cheaper

AEROFIN CORPORATION 101 Greenway Ave. Syracuse 1, N. Y.

Aerofin is sold only by manufacturers of fan-system apparatus. List on request.





ELLIOTT VACUUM EQUIPMENT

maintains pressure of 75 to 100 mm Hg absolute in crude oil distillation unit

TWO-STAGE EJECTORS, with an Elliott 20,000-sq. ft. precondenser, a 3000-sq. ft. intercondenser, and a 900-sq. ft. aftercondenser were designed by Elliott Company to serve a new distillation unit. Suction chambers and diffuser inlets of the three 12-inch first-stage ejectors are shown at lower left in photo above.

BELOW THE FLOOR, left, are the vertical diffusers of the three 12-in. first-stage Elliott ejectors which exhaust into the 3000-sq. ft. Elliott intercondenser. Two 6-in. second stage ejectors, seen at the right, discharge into the aftercondenser.

ELLIOTT Company
Jeannette, Pa.

GO-2

Meta-Nitrobenzoyl Chloride.....Assays 96% minimum. Used in dye industry as intermediate and in photographic film industry in dyes for color prints. Data sheet.
187c *Hooker Chemical Corp.

Minerals.....Tabulated information on products of aluminum silicate, attapulgus clay, activated bauxite, and limestone is offered for wide industrial usage.
206a Minerals & Chemicals Phillipp

Para-Nitrobenzoyl Chloride.....Assays 98% minimum. Used for preparation of procaine which lengthens effective period of dosage for penicillin. Data sheet available.
187d *Hooker Chemical Company

Plastics.....This 12-page booklet has results of the company's ASTM tests on its styrene, polyethylene and vinyl chloride products and other general information.
206b Monsanto Chemical Co.

Polystyrene Acid Containers.....New case holds four 5-pt. "C.P." acid bottles in contoured pockets formed of shock-resistant low density expanded polystyrene.
49 *Allied Chem., General Chem. Div.

Silicones.....Antifoamers or defoamers job-proved thousands of times over as the most efficient, most economical foam suppressor. Free sample and new manual available.
R199 *Dow Corning Corporation

Solid Lubricants.....The theory and practice of lubrication by molybdenum disulfide lubricants is the primary subject in a new booklet just published.
206c The Alpha-Molykote Corp.

Tungsten Chemicals.....Sodium tungstate, phosphotungstate acid, tungstic acid, tungstic oxide and ammonium paratungstate reveals their properties in this catalog.
206d Sylvania Electric Products, Inc.

Construction Materials

Aluminum.....Aluminum process pipe features easier installation & less corrosion. Details on aluminum process pipe, or aluminum for any process application.
24-25 *Reynolds Metal Company

Cable.....MI cable is ideally suited for all types of trouble areas. Mineral Insulated wiring gives maximum protection from water, ignitible fibers. Brochure.
14-15 *General Cable Corp.

Castings.....Ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. Complete information in Bulletin No. 3150 G.
195 *The Duraloy Co.

Cement.....One-Cote cement insulates, protects & finishes. Effective insulation at temp. up to 1000 F. Ideal for outdoor or indoor installations. Quick-setting.
104 *Eagle-Picher Company

Conduit.....Alcoa aluminum electrical rigid conduit saves installation labor, resists corrosion. Phases may be separated. Protection against ground-fault hazards. Facts.
185 *Rome Cable Division of Alcoa catalog.

* From advertisement, this issue

Ready for shipment, this FEinc Horizontal Filter was custom designed for solvent processing service. The unit is an 8′ diameter, totally enclosed, pressure horizontal filter featuring the unique center shaft design.

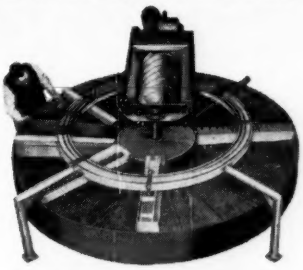
Why settle for less than a FE INC. CUSTOM DESIGNED Horizontal Filter?

FEinc Horizontal Filters custom designed for *any* continuous separation of free-filtering or free-settling materials, such as coarse crystalline materials or fibrous pulps, offer:

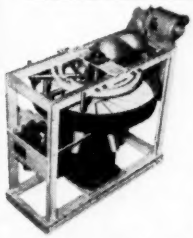
- **Extremely high hourly output.**
- **Multiple-stage or counter-washing for maximum recovery . . . minimum dilution.**
- **Visible results . . . easy control.**
- **Cakes built up to 4″ or more.**
- **No separate foundations . . . can be skid mounted.**
- **Totally enclosed, rubber covered or other special construction.**
- **Sizes from 7.6 to 170 sq. ft.**

FEinc matches the filter, its size, construction materials and special features necessary for highest efficiency to YOUR specific filtration problem . . . *often at no more than standard filter cost.*

INVESTIGATE BEFORE YOU DECIDE. If you have *any filtration problem* . . . contact us. Compare our recommendations and quotations on vacuum or pressure rotary drum — scraper, string or roller discharge — horizontal table or precoat filters. We offer both complimentary laboratory test and pilot plant rental services. See our section in Chemical Engineering Catalog or write Dept. CEF-960.



This 12′ FEinc Horizontal Filter has the conventional roller-tooth gear drive with spur gear engaging roller chain on rotating unit. The ball type main bearing has a replaceable hardened race. Sizes up to 18′ in diameter.



A 3′ FEinc Horizontal Filter offers 7.6 sq. ft. of filter area or about twice as much as most competitive designs. More filter area is available because of the unique center shaft construction. This unit is available for pilot trial in your plant.

For a Bigger Yield **FE INC.®**

FILTRATION ENGINEERS
A DIVISION OF
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS
CUSTOM DESIGNED CONTINUOUS FILTRATION

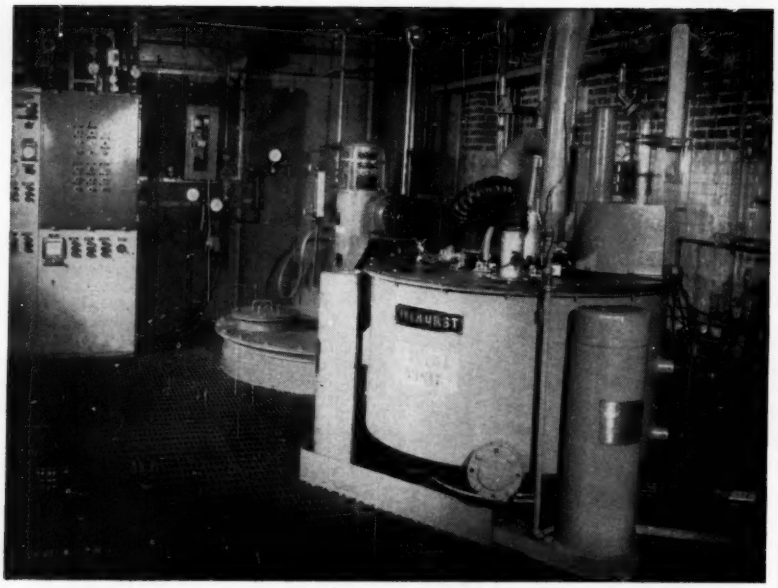
STRING

HORIZONTAL

SCRAPER

Divisions of American Machine and Metals, Inc.

TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS
TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS
NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB
ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASER-STEERS CORPORATION



BATCH-O-MATIC® provides high efficiency and constant quality control at MERCK & CO., INC.

This completely automated Tolhurst BATCH-O-MATIC meets this user's requirements for a dual-purpose extractor.

In the first application, excellent recovery of filtrate is obtained and *solids are discarded.*

In the second application, extremely high purity standards are maintained for solids which are saved. Here, *filtrate is discarded.*

BATCH-O-MATIC operation reduces exposure time and, therefore, maintains product stability.

Automatic operation, no crystal degradation during unloading, stepless variable basket speed, trouble-free performance and low operating costs helped determine the selection of a BATCH-O-MATIC. For more complete data, see the Tolhurst section in Chemical Engineering Catalog or write: Address Dept. CET-960, East Moline, Illinois.

Tolhurst® CENTRIFUGALS

A DIVISION OF

American Machine and Metals, Inc.

Specialists in liquid-solids separation

EAST MOLINE, ILLINOIS

Divisions of American Machine and Metals, Inc.,

TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY GLASER-STEERS CORPORATION

LITERATURE . . .

Condulets.....Corrosive substances are listed in tabular form with appropriate corrosion-resistant metals and finishes used in this company's line of condulets.
208a Crouse-Hinds Co.

Construction.....For low-temperature gas separation in ethylene recovery. "Pre-packaged" assemblies with capacities up to 100 tons or more per day. Information.
R197 *American Air Liquide

Fabricating.....Whatever your plate needs, the staff & facilities to take care of them is available. Booklet describes plate fabricating & construction services.
10-11 *Amer. Bridge Div., U. S. Steel

Fabrication.....Corrosion problems solved through resin bonded fiberglass construction. Process equipment such as ducts, stacks, hoods, etc. Facts in Bul. 101.
231 *du Verre Inc.

Floors, Industrial.....For chemical processing areas, pickling and plating rooms. Form a corrosion-proof base against alkalies, acids, solvents and salts. Bulletin CC-3.
R212b *Atlas Mineral Products Co.

Grating and Treads.....12 pages of engineering data enable the user to identify the type wanted. Tables are also given on Safe Loads and Weights.
208b Kerrigan Iron Works Co.

Insulation.....Foamglas insulation is water-, vapor-, acid-, and vermin-proof. Dimensionally stable. Catalog and Fact Sheet. Also Data Sheets on accessories.
157 *Pittsburgh Corning Corp.

Mastic Coatings.....A resume of a recent talk before the National Association of Corrosion Engineers at Dallas covering preparation and application is available. Bul. M-1.
208c Emjay Maintenance Engineers

Plastic Structures.....Corrosion-proof, self-supporting polyvinyl chloride designed & fabricated for use as tanks, duct & fume systems to meet your exact needs. Bul. CC-3.
R212c *Atlas Mineral Products Co.

Polyolefin Insulation.....Two new brochures are available on an irradiated polyolefin insulation sleeving which shrinks to a preselected diameter when exposed to heat.
208d Raychem Corp.

Refractories.....Bulletin containing extensive tech. information on the properties & application of refractory-type products plus copy of "Super Refractories" offered.
85 *Carborundum, Refractories Div.

Refractory, Silicon Carbide.....Crystolon "63" has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids.
97 *Norton Co., Refractories Div.

Steel.....'T-1" steel cuts pressure vessel weight. Offers a combination of toughness at low temperatures & high strength at elevated temperatures. Information.
34-35 *United States Steel

Thermal Insulation....A 16-page booklet entitled "Rethinking Thermal Insulation" can serve as a guide to whether or not your process should be insulated and how much.
208e National Insulation Mfg. Assn.

* From advertisement, this issue

LITERATURE . . .

Vitreosil.....Fused quartz ware for thermal shock resistance, for guarding purity of your compounds, for outstanding electrical properties, etc. Catalog.
L216 *Thermal American Fused Quartz

Wire Cloth & Filter Cloth.....Available in all alloys, weaves and meshes in sizes up to 244" wide. Roll or cut to size. Details available in Catalog 57.
L197a *Multi-Metal Wire Cloth Co. Inc.

Electrical & Mechanical

Drives.....Air magnetic tube expander drives and also electric control tube expanders and related accessories are covered in descriptive literature.
180 *Elliott Co.

Mechanical Seal.....With a few turns of a wrench, seal assemblies on tank top mixers can be changed quickly, efficiently. Bulletin 601 available on request.
69 *Nettco Corp.

Relays....Improved Bulletin 700 Type B and Type BX relays establishing new standards for relay life and reliability. Details available on request.
57 *Allen-Bradley Co.

Rotating Shaft Seals.....A new complete catalog of this company's rotating saft seals contains information on bellows seals, boot seals, cartridge seals, etc.
209a Cartriseal Corporation

Spacer Couplings.....Are specifically designed for quick installation or removal without disturbing the driving or driven unit. Service Manual 3838 offered.
53 *The Falk Corp.

Speed Reducers.....Engineering data, mounting information, service factors, horsepower, torque and overhung load ratings for seven models are given in a two-color catalog.
209b Winsmith, Inc.

Speed Variators.....Available in 18 models ranging from fractional to 16 hp at 1750 input RPM. Bul. K-200 contains description of photographs, specifications, etc.
77 *Cleveland Worm & Gear Div.

Unilets, Aluminum.....The line includes 7 of the most popular types in ½", ¾" & 1" sizes. Bulletin No. AL 60 includes details for the entire aluminum product line.
1 *Appleton Electric Co.

Handling & Packaging

Air Conveyance Systems....Flo-Tronics Fluidazation systems—complete or in components can be custom-built to your specification. Engineering evaluation and facts available.
230 *Flo-Tronics Inc.

Bags, Multiwall.....Information on the types of multiwall bags, the principal types of closures, proper storage and handling of multiwall bags are all included.
209e Bemis Bro. Bag Co.

Boxes, Wooden.....Not intended to be used merely as a catalogue of available designs, "Bin Boxes" contains information on selection of wooden handling containers.
210a National Wooden Box Ass.

* From advertisement, this issue

NIAGARA VERTICAL FILTER AT KIND AND KNOX GELATIN COMPANY, CAMDEN, N. J.

"In half the time needed by our old filter press, we can run a batch of gelatin in the thin liquor stage through our new NIAGARA VERTICAL FILTER," says Edward Bohn Jr., assistant plant superintendent for one of the largest U. S. gelatin producers.

Remarkable reductions in down time and labor costs also are reported by Kind and Knox with its new NIAGARA FILTER. "Resetting the NIAGARA for a new run takes one-fourth the time and one man can handle the procedure without a helper," Bohn says. "Our regular filter press requires two men working two hours to change 50 filter cloths. With NIAGARA, hot water under pressure completely removes the residue in minutes, and the unit does not have to be opened. Also, there are no filter cloths to clean or replace in our NIAGARA FILTER."

The plant operates 24 hours a day, 7 days a week, and to date there has been no operational trouble with the NIAGARA FILTER. This compact filter has a base measurement of only 52" x 102", so there is a big savings in floor space.

For details on how custom engineered NIAGARA FILTERS can help with your processing problems, write for bulletin NC-457, or see the NIAGARA section in Chemical Engineering Catalog.

Niagara® FILTERS

A DIVISION OF

American Machine and Metals, Inc.

DEPT CEN—960

EAST MOLINE, ILLINOIS

Divisions of American Machine and Metals, Inc.,

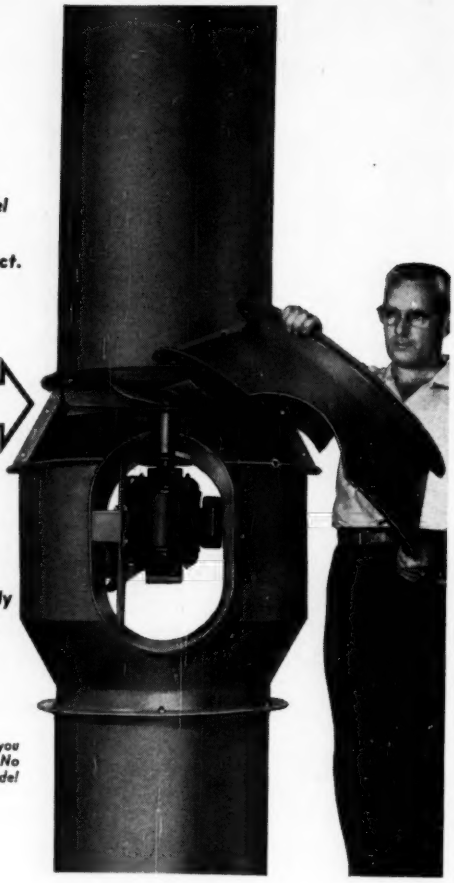
TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY GLASER-STEERS CORPORATION

Now . . . pull the fan wheel or motor while DeBothezat® Bifurcator® Fan remains in duct.

Not just an access door. Half the entire cone comes off.

Speed up inspection . . . slash maintenance and downtime costs.

This removable cone design is an exclusive feature found only on DeBothezat Bifurcator Fans.



Published ratings on DeBothezat Fans tell you exactly what the complete fan unit puts out. No guess work — no allowance to be on safe side!

New design duct fan

De Bothezat® FANS

DIVISION OF

American Machine and Metals, Inc.

EAST MOLINE, ILLINOIS

Divisions of American Machine and Metals, Inc.

TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DEBOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY GLASER-STEERS CORPORATION

THIS COUPON ANSWERED WITHIN 24 HOURS

DeBOTHEZAT FANS DIVISION, Dept. CED-960
American Machine and Metals, Inc.
East Moline, Illinois

Gentlemen: Your new Removable Cone feature for DeBothezat Bifurcator Fans looks good to me. Please rush descriptive literature at once.

NAME

FIRM NAME

ADDRESS

CITY & ZONE STATE

LITERATURE . . .

Caustic Soda Bags.....Approved for both rail and truck shipment in 50 and 100 lb. sizes. Offer easier, cheaper disposal. Complete details available.
63 *Bemis Bros. Bag Co.

Conveyors.....Two different pamphlets, "Pneumatic Hydraulic Mechanical" and "Chip Handling and Oil Reclamation Systems," show equipment in use.
210b National Conveyors Co.

Equipment, Gas Handling.....Efficient and economical cleaning and handling. Complete systems from design to installation. Information available upon requests.
198 *Aerotec Industries Inc.

Exhausters.....Clarage Type CI Exhausters have volumes to 3800 CFM, pressures to 18", temperatures to 750°F., six sizes, three wheel types and five arrangements. Catalog 707.
151 *Clarage Fan Co.

Feeders.....Rotary airlock feeders for use in handling problems of dust control and for pneumatic conveying. Bulletin P58 available upon request.
B184 *Prater Pulverizer Company

Gaskets, Chempac.....Are soft, conformable and effect a seal at low bolting. Available in pipe sizes from ½" to 12" as standard. Chempac Book PK-124 A.
47 *Johns-Manville

Hoists and Cranes.....Data on general features of all units and components, mountings, specifications, weights, dimensions and lifting capacities given in 8-page folder.
210c American Chain & Cable Co.

Labels, Gummed.....This bulletin is actually printed on the gummed label paper which is described. Sample labels and typical colors are also included.
210d Kalamazoo Label Co.

Packing.....Teflon Shaft Packings are ideal for use on either centrifugal or reciprocating pumps at temperatures from 118° + 525° F. Chempro Bulletin CP 552.
186 *Chemical & Power Products Inc.

Screw Conveyors & Components..... The 76-page Book 2989 contains detailed sections on components, layout, drive arrangements, dimensional data, etc.
12 *Link-Belt Co.

Seamless Cylinders.....Are shipping containers for chlorine, hydrogen chloride, boron trifluoride, & many other compressed gases. Complete range of sizes & shapes.
13 *Pressed Steel Tank Co.

Storage.....Flow racks for live storage are explained by photographs, drawings and diagrams in an eight page booklet which also cites case histories of installations.
210e The Rapids-Standard Co.

Tanks.....A new 8-page Ultralite Tank Insulation Brochure offers the most comprehensive and current information available on the who-what-why-when-and-how.
145 *Gustin-Bacon Mfg. Co.

Tanks.....Pickling, plating, chemical processing and storage tanks with corrosion-proof linings and cements. Resist all types of corrosives. Information in Bul. CC-3.
R212a *Atlas Mineral Products Co.

* From advertisement, this issue

Timing Devices.....“5 Simple Steps to the Selection of Timing Belt Drives” gives a method involving a minimum of math for the selection of a timing belt drive.
211a T. B. Wood's Sons Company

Heating & Cooling

Air Preheater.....Information on the Ljungstrom continuous regenerative principle, or on the Air Preheater that meets your requirements is available.
90 *The Air Preheater Corp.

Condenser, Vapor.....Produces constant temperature, gives higher vacuum with use of less steam and power. Mounted on steel structor of distillation column. Bulletin 129.
R218 *Niagara Blower Company

Cooler.....Blown Film Cooling Capacity uses air ring to provide faster “bubble” cooling for higher production speeds. Complete details are available upon request.
193 *Davis-Standard

Dryers, Desiccant.....Are designed to dry air & gases under pressure (ranging from 1000 to 6000 psig) to dew points of −160 F. Full details in Bulletins D-108 & D-109.
65 *The C. M. Kemp Mfg. Co.

Extreme Temperature Equipment..... A high point of this 32-page color brochure is a pictorial chart giving atmospheric conditions up to two million feet altitude.
211b Webber Mfg. Co.

Furnaces and Ovens.....A new catalog offers a comprehensive description of this company's line of industrial furnaces and ovens, with specifications for each model.
211c L and L Mfg. Co.

Furnaces, Treating-Processing..... Laboratory services, custom roasting and pilot plant equipment are available. Information on Multiple Hearth Furnaces in Bul. 233.
32 *Nichols Engineering & Research

Heaters, Electric Radiant.....Precisely controlled Chromalox Radiant Heaters pre-heat plastic-coated paper for embossing without burning or scorching. Bulletin G62.
105 *Edwin L. Wiegand Co.

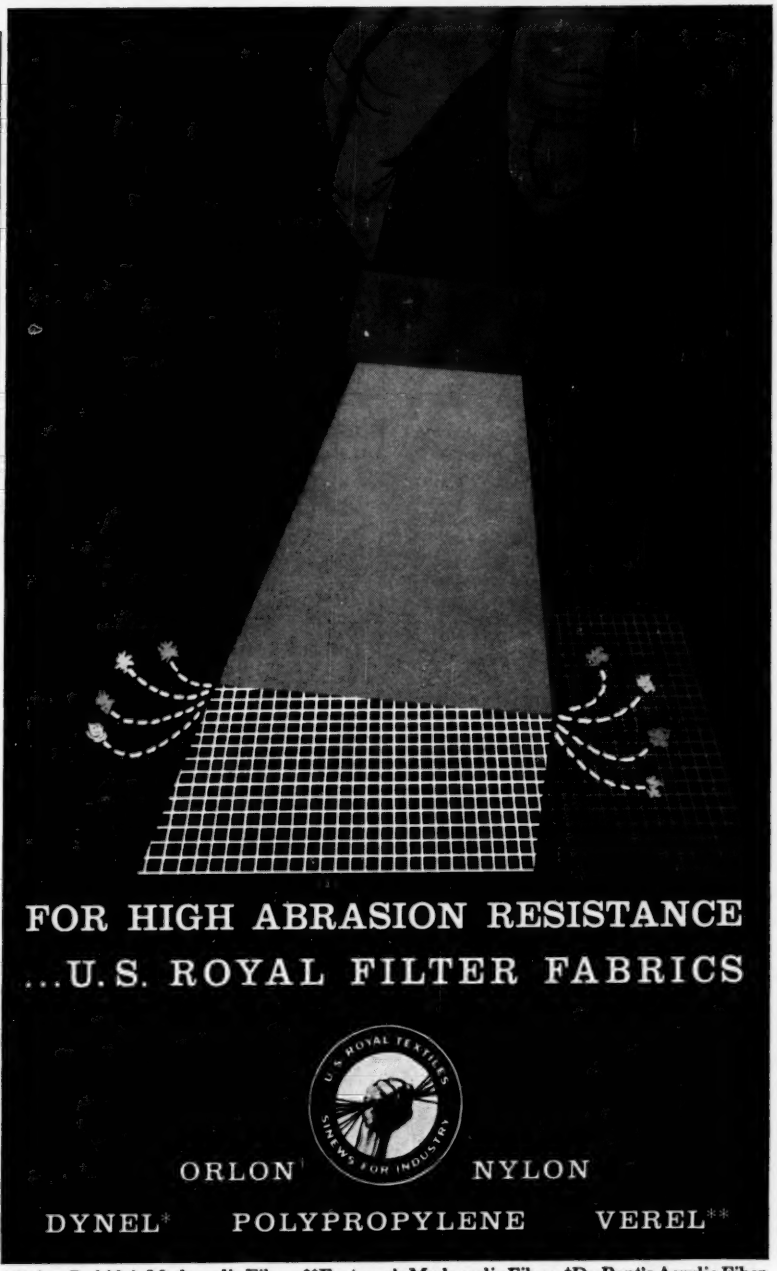
Heat Exchangers.....Of the low pressure double-pipe type are described in this 8-page color brochure. The exchangers' efficiencies, sizes, and materials are listed.
211d Brown Fintube Co.

Heat Exchangers.....Type 0 Low Pressure Heat Exchangers feature two stud flanges that greatly simplify installation and maintenance. Bul. 110 available on request.
55 *Brown Fintube Co.

Heat Exchangers, Plate.....Stainless steel. Plates and heaters can be added for easy expansion. Capacity range to 1600 sq. ft. Compact Information available.
16-17a *De Laval Separator Co.

High Vacuum Still.....Offers stability of odor, taste and color, consistency of product and higher yields. High Vacuum Still Bulletin 3-1 and samples offered.
R217 *Consolidated Vacuum Corp.

* From advertisement, this issue



FOR HIGH ABRASION RESISTANCE
...U.S. ROYAL FILTER FABRICS

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DYNEL* POLYPROPYLENE VEREL**

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Filter fabrics by U. S. Rubber, engineered to exacting service requirements, provide more than extremely high resistance to abrasion. They offer maximum chemical and heat resistance, efficient cake retention-and-discharge properties. Write, wire or phone your specific requirements to Industrial Textiles Department at the following sales offices:

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Textile Division
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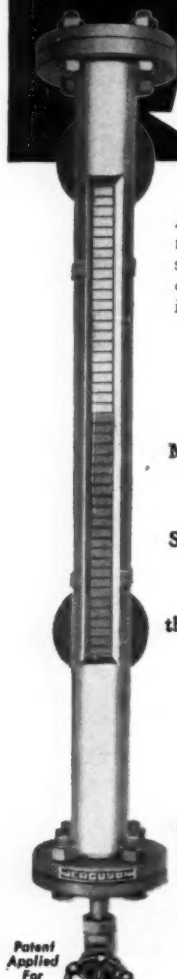
the New Jerguson

MAGNETIC GAGE

for liquid levels



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

Available with electric alarms.

Can also be used for interface indication.

Patent Applied For

Write now for engineering sheet on Jerguson Magnetic Gages.

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Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
In Canada: Peacock Bros. Ltd.

See exhibited at ISA SHOW, Booth 323

LITERATURE . . .

Panelcoil.....Offer fast, efficient heat transfer. Easier to install. New Technical Data Sheets Nos. 15-60 series and Price Bulletin available on request.
BL213 *Dean Products, Inc.

Instruments & Controls

Chromatograph, Industrial Gas..... Detailed instrument specifications and answers to your process control problems are contained in data file 14-37-07.
153 *Beckman Instruments, Inc.

Closed Circuit TV.....Lightly written with a serious intent, this booklet explains industrial and commercial television in laymen's language within 9 pages.
212d General Precision, Inc.

Computers.....Or, more precisely, how to speak the strange language called "computerese" is explained in a 22-page glossary of terms (bit, flip-flop, nixie light, etc.
212e Monneapolis-Honeywell Reg. Co.

Control System.....The new FRAC controller is easy to use & maintain. Features components that are fully transistorized. Complete details on request.
36-37 *Minneapolis-Honeywell

Electric Motor Controls.....56 pages describe ratings and prices for manual and magnetic starters, drum controllers, pressure, foot and limit switches.
212f Furnas Electric Co.

Instrumentation.....Many case histories are cited in a new booklet, "Instrumentation for Treatment of Industrial Water." Systems used in processing are described.
212g Minneapolis-Honeywell Co.

Magnetic Gage.....For liquid level observation for plants with dangerous explosive or inflammable conditions. Available with electric alarms. Engineering Sheet offered.
L212 *Jerguson Gage & Valve Co.

Instrument.....Elect-O-Level provides a continuous indication for level measurement & control of liquids, solids, viscous fluids, acids & granular materials. Bul. L-1053.
BL219 *Instruments, Inc.

Meters.....The Type 316 stainless steel meter for measuring liquid fertilizer & corrosive chemical solutions. Accuracy ±.5% (20-100 GPM). Descriptive Literature.
BL199 *Badger Meter Mfg. Co.

Meters.....A complete description of Niagara Chemical Meters, including High Pressure, Steam Jacketed, and Electricontact Models is contained in Bul. 43.
190 *Buffalo Meter Co., Inc.

Pulsafeeders.....Information on applications of Pulsafeeders of a multitude of capacities and constructions are contained in Catalog 59. Send for your copy.
83 *Lapp Insulator Co.

Transmitter, Indicating.....Bul. 21-10 describes the Type 630 Indicating Transmitter in detail as well as the many other instruments in Electronic Consotrol System.
28-29 *The Foxboro Company

* From advertisement, this issue

Atlas

INSTALLATIONS PROVIDE PERMANENT CORROSION PROTECTION!

tanks

Pickling, plating, chemical processing and storage tanks of all kinds, utilizing corrosion-proof linings and cements, are designed and constructed by Atlas to completely resist all types of corrosives.

floors

Atlas industrial floors for chemical processing areas, pickling and plating rooms form a corrosion-proof base against attack by alkalies, acids, solvents and salts.

hoods, ducts, fume systems

Rigid plastic structures, designed and fabricated by Atlas from polyvinyl chloride, exhaust all types of corrosive fumes. Plastic tanks and piping systems contain and convey corrosive solutions. All are completely corrosion-resistant throughout.

These Atlas installations will permanently protect your client's plant from corrosion. Write for Bulletin CC-3.

ATLAS MINERAL
MERTZTOWN, PENNSYLVANIA

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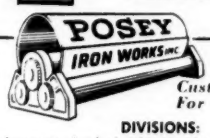
REFINERY VESSELS

Fractionators, receivers, absorbers, scrubbers, refinery vessels of all types fabricated to your specifications.

For FREE 16-page illustrated catalog on heavy steel plate fabrications, write:



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DIVISIONS:
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• Large OD Steel pipe

557 S. PRINCE STREET LANCASTER, PA.

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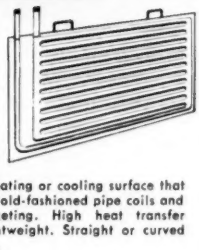
DEAN® PANELCOIL
FOR HEATING—COOLING



Our latest Technical Data Sheets Nos. 15-60 Series give engineering specifications on Dean Panelcoil — the highly efficient heating or cooling surface that takes the place of old-fashioned pipe coils and conventional jacketing. High heat transfer rate. Sturdy. Lightweight. Straight or curved to fit any surface.

Latest Data Sheet 15-60 Series and prices sent on request.

Dean Panelcoil formed by welding two sheets of metal together, with one or both sheets embossed, to form leakproof integral flow channels for steam, refrigerant, etc.

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Backed by 25 Years of Panel Coil Manufacturing

LITERATURE . . .

Pipe, Fittings, Valves

Closures, Hinged.....Are available in sizes 2" through 42" for A.S.A. 150-lb., 300-lb. & 600-lb. service...in steel or alloys. Bulletin TT956 is offered.
8-9 *Tube Turns Div. of Chemetron

Gear Operators.....New Convorto-Gear valve operator has carburized alloy steel gears with 4.11 to 1 ratio. Anti-friction bearings reduce operating effort. Information.
20-21 *Crane Co.

Joints, Expansion.....Catalog 56 contains complete & comprehensive engineering data for expansion joints from 3" to 50' diam., pressures to 3600 psi, temp. to 1600F.
93 *Zallea Brothers

Joints, Swivel.....Offers complete flexibility. Designed to use either disc or molded type packings. Requires only routine lubrication. Bulletin No. 1258.
168-69 *Chiksan Company

Pipe, Alloy-Bonded.....The 98% nickel-2% phosphorous alloy bonded product is said to be as effective as heat exchange tubing or as steam coil piping in sulfur tanks.
213a M. L. Sheldon & Co., Inc.

Pipe.....Bondstrand is available in sizes from 2" through 8". Bulletin contains complete data, including physical properties, chem. resistance, flow rates, etc.
165 *Amercoat Corp.

Pipe.....Saran Lined Pipe carries process liquors with sulfuric acid content of 25% at temperatures of 165° F. and above. Pumping pressures to 70 psg. Information.
183 *The Dow Chemical Company

Tube....."The Story of Tube" is told in the colored photographs and illustrations contained in this new brochure. Includes the Tube Mill Products Selector charts.
213b Scovill Mfg. Co., Mill Prod. Div.

Tubing....Lectrosonic designed to meet need of petrochemical industry for electric resistance welded carbon steel that is easily workable, strong, etc. Bul. T-431.
102 *Babcock & Wilcox Co.

Valves.....12-page bulletin describes in detail line of full capacity, three way valves for air, oil, water, gas, chemical or vacuum service. Bulletin includes ordering information.
213c Airmatic Valve, Inc.

Valves.....A catalog describes shut-off, pressure relief and flow check valves, driers, filter-driers, strainers, liquid guages, flanged unions, and liquid indicators.
213d Henry Valve Co.

Valves.....Feature heat and wear resisting stainless steel yoke nuts. Valves available in a complete range of sizes from ¼" to 2". Catalog F-10 available.
106 *Henry Vogt Machine Co.

Valves, Aluminum Alloy Gate.....New economies in handling of "problem" fluids and gases wherever aluminum piping is used. Bulletin
R189b *Darling Valve & Manufacturing Co.

* From advertisement, this issue

Facts-of-Life for successful engineers must include attitude, self-appraisal, vision, understanding, respect, relaxation and "happiness"

Achieving "success" and/or "happiness" in your professional and personal future won't just "happen," regardless of how diligently you apply yourself to your daily tasks, unless your efforts are coordinated along specific paths of endeavor. Your life as an engineer must be counterbalanced by your life as an individual — because "engineers ARE human," despite comment to the contrary.

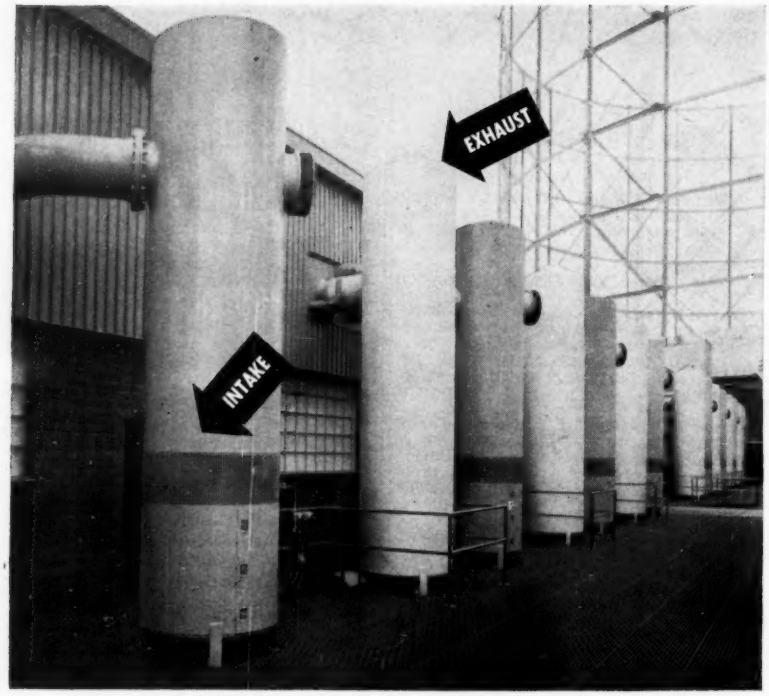
The engineer reacts to the same human stimuli and motivations as the man in the accounting division, the sales department, the repair and maintenance crew, the general office force, or in the management division. All are motivated to varying extents by the same drives for recognition, self-respect, material progress, functional importance, personal pleasure, financial stability — and "security," however, the latter is translated.

The fact of the matter is no longer "theoretical," it is accepted, proven, practical "common-sense": to accomplish either or both of these achievements, your pursuit of "happiness" and/or "success" must have (a) ambition, (b) definition, (c) purpose, (d) direction. It is a life-long pursuit, subject to many detours and changes. In the pursuit itself, however, will be found much of its own reward.

One of our basic problems seems to stem from our relationships with *others* — our reactions to the drives of other people and their reactions to ours, because, like it or not, we *are* affected by other people, and they are affected by us.

Professionally, we are affected by our superiors, associates and subordinates — both technical and non-technical. Personally, we are affected by our family, our relatives and our friends — on and off the job. Our object then, is to ascribe to both our professional and personal life those qualities and human attributes which bring professional success and personal happiness. *We must develop a formula for living.*

This limited space, of course, does not permit a full look at this most complex of subjects, but a more complete treatment of human relations in engineering is found in a booklet entitled "Success and/or Happiness — in Engineering," available free upon request. Write for your copy to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and remember, *our* success and happiness stems partially from the heat exchangers in *your* future.



For remote- or engine-mounted turbochargers

SILENT TWINS Increase Operating Efficiency... Provide Clean, Filtered Air Intake and Optimum Exhaust Silencing

Burgess-Manning Silent Twins, matched units for remote- or engine-mounted turbochargers, provide clean, filtered intake air at minimum pressure drop and optimum silencing efficiency on both sides of the system. Silent Twins are available for vertical or horizontal installation, and afford flow-conditioned, compact piping for best operating efficiency of either proposed turbocharged engines or turbocharging of existing engines.

Silent Twins can be furnished with either of two types of filters — depending upon the dust load. One is petrolatum-treated hogshair, extensively used in the Gulf Coast area, the Eastern United States, and other light dust load areas. For the Western United States and in areas where heavy dust is a factor, we recommend a special felt material that will load up and hold dust and dirt of a very small micron size without carrying over to the engine. Both types have proved to be the best-accepted, lowest-cost, and lowest-maintenance filters available. The filters are contained in a compact cartridge which is easily installed and removed through large access doors in the filter chamber.

Burgess-Manning intake and exhaust silencers are scientifically engineered to prevent — not muffle — noise produced by the exhaust of internal combustion engines, discharge of rotary blowers, vacuum pumps, hogging jets, and steam safety valves, and at the intake of reciprocating compressors and rotary blowers. Silencing of the exhaust stream is obtained by passing the flow through snubbing chambers so that it is discharged to atmosphere smoothly and quietly. Burgess-Manning Snubbers are built like pressure vessels, continuously welded throughout, without excessive weight. A wide range of both standard and special units is available for 1" through 30" and larger pipe sizes.

In our more than 50 years' research and engineering for all types of industries, we have never failed to solve a noise problem. If noise is a problem in your plant, or if you are designing a plant where turbochargers are to be installed, talk to "The Sound Engineering People." There's no obligation, and you'll find us anxious to help you in any way we can. Burgess-Manning Company, 9246 Sovereign Row, Dallas 7.

Industrial Silencer Division
BURGESS-MANNING COMPANY
The Sound Engineering People
Sales Engineering Representatives World-Wide

LITERATURE . . .

Valves, Ball.....Seven data sheets giving various information about a complete line of "Double-Seal" Ball Valves and accessories are now available on request.
87 *Jamesbury Corp.

Valves, Control.....Conoflow LB control valves provide tight shutoff, give maintenance-free performance. Demonstration available. Also Bulletin LB.
30-31 *Conoflow Corporation

Valves.....Darling-McEvoy self-sealing conduit valves have sealant gasketing between gates and seats. Closures leakproof. Catalog 57.
R189c *Darling Valve & Manufacturing Co.

Valves, Diaphragm.....Offer positive, leak-tight closure; flow control in throttling position; corrosion-resistance. Used in petroleum, food, chemical & other fields. Facts.
75 *Grinnell Company

Valves, Electrically Operated.....A 20-page illustrated booklet gives descriptions, specifications, features, flow charts and other data for 2, 3, and 4-way valves.
214a Airmatic Valve, Inc.

Valves, Gate....Fully revolving double disc gate valves give easy operation, surer closure, minimum friction, maintenance. Catalog 57.
R189a *Darling Valve & Manufacturing Co.

Valves, Globe & Angle.....For applications requiring valves for service temp. from 0 to 212°F., pressures to 400 psig WOG. Applications & specifications. Bulletin L-475.
R219 *The Bastian-Blessing Co.

Valves, Heavy Duty.....Heavy Duty "Kwikleen" Valve for line pressures to 60 psi. Ideal for pulp, stock, slurries, dust, fly ash, scale. Bulletin 508.
R216c *W. S. Rockwell Company

Valves, Lubricated Plug.....Complete line with sizes, pressures & special operating accessories to fit your needs. Literature is now available on request.
176 Rockwell Mfg. Co.

Valves, Safety Relief.....Are available in both Standard and Balanced Bellows design for extreme corrosive applications. Complete details in Bul. 1940.
91 *Manning, Maxwell & Moore, Inc.

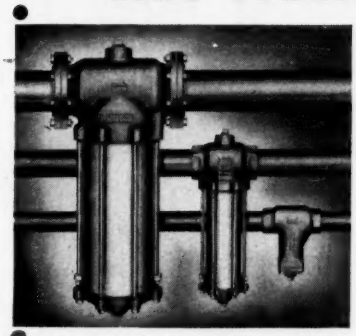
Valves, Slide......"Kwikleen" Slide Valve allows you to clean without removing from line. Sediment discharged at bottom. Bulletin 501R gives more information.
R216b *W. S. Rockwell Company

Valves, Slide.....Standard Slide Valve, screwed end type of flanged. When fully open, offers no restriction to fluid flow. Additional information in Bulletin 500R.
R216a *W. S. Rockwell Company

Valves, Stainless Steel.....Catalog No. 59SS covers the outstanding features of these valves. Satisfy the requirements of practically any type of service.
94 *Jenkins Bros.

* From advertisement, this issue

LINE STRAINERS



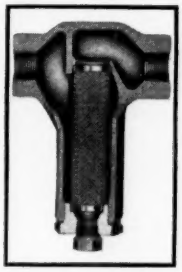
for **SPRAY NOZZLE** SYSTEMS and RELATED APPLICATIONS

in stainless steel, cast iron and brass

A complete range of capacities in ¼" to 4" female pipe connection sizes . . . and in 3" to 6" flange connection sizes. Keeps lines clear for efficient operation. Easily flushed.

TOP PERFORMANCE DESIGN

Screen area so large that strainers will take 75% blocking with less than ½ lb. pressure drop under normal flow conditions. Top and bottom flange collars on screen give seal fit and rigidity.



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3275 Randolph Street
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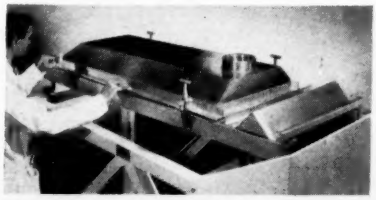
WRITE FOR your free copy of BULLETIN 94 ...gives complete information

ENTOLETER *announces...*

BIGGEST ADVANCE IN SIFTERS

THE *Cirlyptic*® SIFTER

A new line of the highest efficiency sifters has just been added to the Entoleter line of processing equipment... The unique Cirlyptic Sifter action retains product in suspension thereby providing particles more angles of approach and maximum screen put-through. No surface friction greatly reduces screen blinding.



FOR MILK POWDER, PHARMACEUTICALS, PRE-MIX FOODS, CRYSTALS, FLOUR, CHEMICALS, ABRASIVES.

- Highest put-through capacity per screen area.
- No rubber balls to contaminate product.
- Flexibility of speed to achieve optimum screening action.
- All stainless steel construction.
- Meets rigid sanitary requirements.
- One minute disassembly for positive operator cleaning — Simple 3-part construction.

Also Multiscreen Cirlyptic Classifier. Up to 4 positive cuts without screen stacking.

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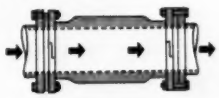
PINCH VALVES

RUBBER, NEOPRENE
for Corrosion and Abrasion

- 1" to 14" inside diameter.
- Pressures to 150 psi.
- Temperatures to 200° F.
- Patented "hinged" sleeve. Recesses serve as "hinges" during compression; reduce strain and permit tight closing.

- Cannot leak or stick.
- No working parts in contact with pulp or liquid; no packing glands.



- Unobstructed flow eliminates high friction loss.
- Remote control available.
- Can be equipped for automatic regulation.

- Split flanges and patented Flex Seal ends assure perfect seal.

See Booth 302, American Mining Congress Las Vegas meeting, October, for latest advancement in valve automation.

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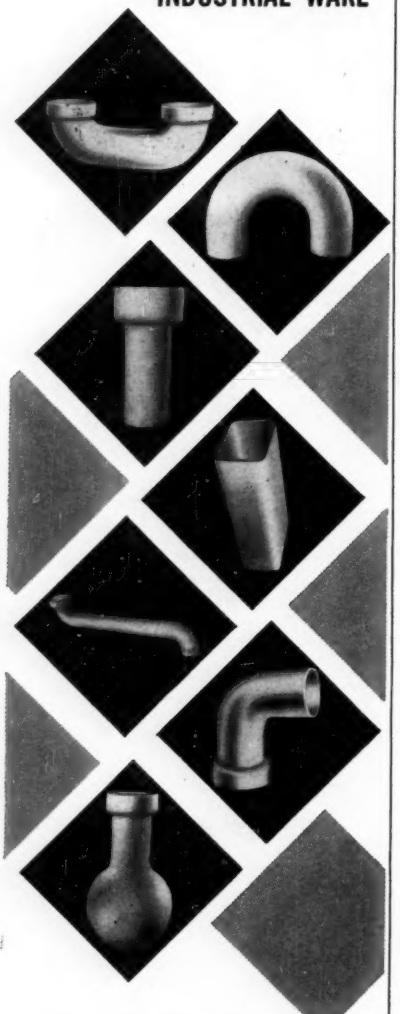


EASILY MEETS CRITICAL PRODUCTION REQUIREMENTS

- Absolute Chemical Purity
- Extreme Heat Resistance
- Thermal Shock Resistance
- Chemical Inertness
- Outstanding Electrical Properties
- Full Range Radiant Energy Transmission

Many standard shapes and sizes . . . and we fabricate for special needs. See our ad in **Chemical Engineering Catalog.**

Write for complete, illustrated catalog.

THERMAL AMERICAN FUSED QUARTZ CO., INC.
18-20 Salem St., Dover, N. J.

LITERATURE . . .

Process Equipment

Bleaching Towers.....A new design for a concentric bleaching tower which is just being introduced is described in this 4-page bulletin, No. 3307.
216d Dorr-Oliver Inc.

Bubble Trays, Float Valve.....The fundamentals of design and operation, mechanical features, operating results, general design and arrangement are all included.
216e Nutter Engineering Co.

Centrifugals.....Batch-O-Matic reduces exposure time, maintains product stability. Automatic operation, low costs. Complete data.
208 *American Machine & Metals Inc.

Centrifuge.....Hollow-bowl centrifuge operates on horizontal plane. Continuous separation effected by screw conveyor. Exposure to 2000 G's. Information available.
16-17e *De Laval Separator Co.

Crushers.....Intended to be used as a guide to preliminary crusher selection, this bulletin is keyed into more detailed bulletins on specific crusher design.
216f Pennsylvania Crusher Div.

Demineralizer.....Produces demineralized water at flow rate of 2500 G.P.H. Details on mixed-bed, single-bed, two-bed & four-bed models in New Catalog 160.
181 *Barnstead Still & Sterilizer

Demineralizers.....Fully automatic operation, shipped completely "packaged." Available in mono-column, dual-column and multi-column types. Full catalog.
R220 *Penfield Manufacturing Co., Inc.

Discs.....Material in process can be viewed continuously. Binder is unnecessary in many cases. Bulletin No. 247 covers all the features and applications.
TL219 *Dravo Corporation

Dissolvers.....New Super Series Dissolvers provide variable speed, big-power mixing in fixed tanks. Features self-cleaning, non-clogging impeller.
81 *Morehouse-Cowles, Inc.

Dust Collector.....The W Roto-Clone requires little maintenance, uses a minimum of water & maintains efficiency regardless of variation in air volume. Bul. 272B.
86 *American Air Filter Co.

Filters.....Details on how custom engineered Niagara Filters can help with your processing problems is contained in Bulletin NC-457 which is now available.
209 *American Machine & Metals, Inc.

Filters.....FEinc Horizontal Filters are custom designed for **any** continuous separation of free-filtering of free-settling materials. Data available.
207 *American Machine & Metals, Inc.

Filters.....Rotary drum filters are costumed designed to meet your specific need. Handle any job efficiently. More detailed information available on request.
204 *Goslin-Birmingham Mfg. Co. Inc.

Filters, Dust.....Capture sub-micron particles. Filter media porosity maintained automatically by high velocity reverse jet air. Facts in Bulletins F-75 and G-579.
170 *The Day Company

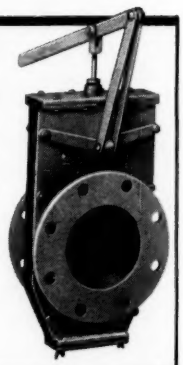
* From advertisement, this issue

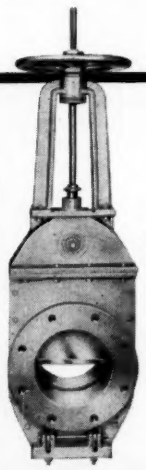
ROCKWELL SLIDE VALVES

for GASES SLURRIES OR FREE-FLOWING SOLIDS THAT CLOG OR JAM OTHER VALVES...

Standard Slide Valve, screwed end type or flanged (shown); when fully open, valve offers no restriction to fluid flow. Bulletin 500R.

"Kwikleen" Slide Valve—Not necessary to remove from line for cleaning. Sediment discharged at bottom. Complete cleanout by attaching steam, water or air line to plug hole in valve body. Bulletin 501R.





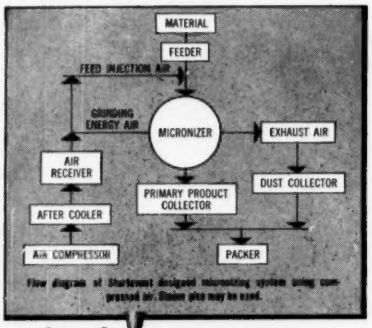
Heavy Duty "Kwikleen" Valve for line pressures to 60 psi. Blade not exposed when in fully open position. Ideal for pulp stock, slurries, dust, fly ash, scale, granular materials. Bulletin 508.

W. S. ROCKWELL CO.

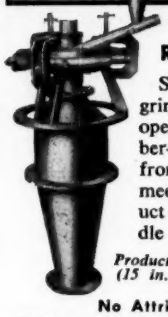
2300 Eliot St., Fairfield, Conn.

Need ½ to 44 Microns?

Sturtevant Micronizers* Make 325 Mesh Obsolete



Flow diagram of Sturtevant designed micronizing system using compressed air. Steam also may be used.



One Operation Reduces, Classifies

Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from ½ to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

Production Model (15 in. chamber)

No Attritional Heat

Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant accessibility, easy cleaning. No moving parts.

Classifying is Simultaneous

Centrifugal force keeps oversize material in grinding zone, cyclone action in central section of chamber classifies and collects fines for bagging. Rate of feed and pressure control particle size.

Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (½ to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

Engineered for Special Needs

A 30 in. Sturtevant Micronizer is reducing titanium dioxide to under 1 micron at feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200-1400 lbs. per hr. A pharmaceutical house uses an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns.

Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

Can Test or Contract Micronizing Help You?

Test micronizing of your own material, or production micronizing on contract basis, are part of Sturtevant service. See for yourself the improvement ultra-fine grinding can contribute to your product. Write for full details. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

*REGISTERED TRADEMARK OF STURTEVANT MILL CO.

LITERATURE . . .

Filter Leaves.....“Rim-Lok” and other multi-leaves for pressure filters; standard leaves for stationary and rotary filters. Additional information in Catalog 57.
L197c *Multi-Metal Wire Cloth Co. Inc.

Filter Medium.....Neva-Cloth available in double layer, perforated, alloy sheet medium. Smooth, strong, rigid for diatomite filters, centrifuges, other. Catalog 57.
L197b *Multi-Metal Wire Cloth Co. Inc.

Floats, Industrial.....A complete line in a wide range of sizes. Bulletin on styles, sizes, shapes, spud connections and recommendations is offered.
TC233 *Chicago Float Works

Fluidics.....16 pages give, to name a few, corrosioneering, reactions, centrifuging heat transfer, storage, agitation, ion exchange, gas analysis, flow rates and waste treatment.
217a The Permutit Co.

Micronizers.....Grind and classify in one operation in a single chamber. Provide fines in range from ½ to 44 microns. Can handle heat-sensitive materials. Bul. 091.
L217 *Sturtevant Mill Company

Mill, Colloid.....Model 2A available for processing quantities as small as 8 oz. For use in research, laboratory or pilot plant.
234a *Manton Gaulin Manufacturing Co.

Mixers.....Shear-Flow new Model RL portable mixer reduces mixing time, gives uniform circulation, controllable flow pattern, emulsifies immiscible liquids. Details.
182 *Gabb Special Products Inc.

Mixers.....Two bulletins describe two new lines, B-520 for portable mixers, and B-521 for fixed mounting propeller-type mixers, designed as integral process units.
217b Mixing Equipment Co.

Mixers, Batch.....Five quarts to 160 cu. ft. Hand and motor driven models. All sizes available in stainless steel, other alloys. Bulletin X-19R offered.
T184 *Daffin Manufacturing Company

Mixers, Dispersall.....Blends, disperses, emulsifies, dissolves, mixes. Standard sizes from ½ to 330 gallons. Facts given in Dispersall Catalog 78.
194 *Abbe Engineering Co.

Mixers, Horizontal.....Bulletin 128-A covers a variety of standard and special designs for efficient mixing and blending of chemicals, drugs, food and other products.
217c Sprout, Waldron & Co.

Mullers.....intensive kneading, smearing, spatulate action serves to actually coat one material with another. Handbook on Mulling available on request.
103 *National Engineering Company

Process Equipment.....Solids-Processor combines vacuum drying & liquid-solids blending in one fully packaged unit. All equipment described in new catalog No. 16-P.
44-45 *Patterson-Kelley

Process Equipment.....The Turbulizer solves many dispersion problems in the chemical & food industries. Features heavy steel shell with machined interior. Information.
79 *The Strong Scott Mfg. Co.

* From advertisement, this issue

Distill with CVC HIGH VACUUM for 1/10 cent per pound!

Process the widest range of organic and silicone compounds (from 250 to 4000 molecular weight) at today's lowest cost. That's because CVC high vacuum distillation requires lower evaporation temperatures—greatly reducing thermal hazards *and* heat input costs. This means:

Stability of odor, taste and color—you upgrade your distillates.

Separation of polymers—not possible by any other method.

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CVC Stills run virtually unattended to save you man-hours. Choose from 4 models to attain throughputs of from 2 to 4000 pounds per hour.

WRITE for High Vacuum Still Bulletin 3-1 and for information on test runs of your samples.

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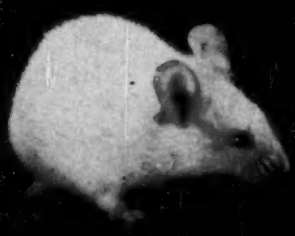
Consolidated Vacuum Corporation
ROCHESTER 3, NEW YORK

a vacuum pump as quiet as a . . .



Steady and silent. That's the new Stokes Series H Microvac pump. Unique dynamic balancing provides hushed operation. And the compact Stokes pump saves up to 50% in valuable floor space.

Find out all the reasons why you get *more pumping performance per dollar* with Stokes Microvac pumps. Just write: Vacuum Equipment Division, F. J. STOKES CORPORATION, 5500 TABOR RD., PHILA. 20, PA.

STOKES

SEND TODAY
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LITERATURE . . .

Refinery Vessels.....Fractionators, receivers, absorbers, scrubbers, refinery vessels of all types fabricated to your specifications. 16-page Catalog available.
TL213 *Posey Iron Works Inc.

Rupture Discs.....Corrosion-resistant rupture discs for dependable instant & automatic relief of excess pressure. Additional information available on request.
155a *Engelhard Industries, Inc.

Screen Separator.....Controlled 3-D motion. Simple adjustment of control dials. Quiet, almost vibrational operation. Details available on request.
16-17b *De Laval Separator Co.

Scrubber.....Multi-Wash Scrubbers available to fit your code requirements. Can be supplied in steel alloys, coated, or uncoated, or other special materials. Tech. data.
40 *Claude B. Schneible Co.

Sifters.....Gyro Pedestal sifters feature high speed gyratory action. More data on the Gyro Pedestal sifter is contained in Bulletin 139 which is offered.
192a *Sprout, Waldron & Co., Inc.

Strainers....."Individualized" strainer elements and housings, designed and built to meet process needs not served by available standard units. Details in Catalog 57.
L197d *Multi-Metal Wire Cloth Co. Inc.

Strainers, Line.....Complete range of capacities in ¼" to 4" female pipe connection sizes and in 3" to 6" flange connection sizes. Bulletin 94 gives information.
TL215 *Spraying Systems Co.

Thickeners....."Auto-Raise" device. Has manual or power raise, replaceable ring-type ball bearing support and spiral rakes. Details in Bulletin 31-D-11.
232 *Hardinge Co., Inc.

Unit Machines & Systems.....Packaged processing systems include machinery for crushing, mixing, grinding & sifting plus pneumatic conveying systems. Bul. F-19.
192b *Sprout, Waldron & Co., Inc.

Weighing, Automatic.....This 16-page book, in two colors, contains many illustrations and diagrams describing automatic weighing systems and their components.
218a Dynametrics Corp.

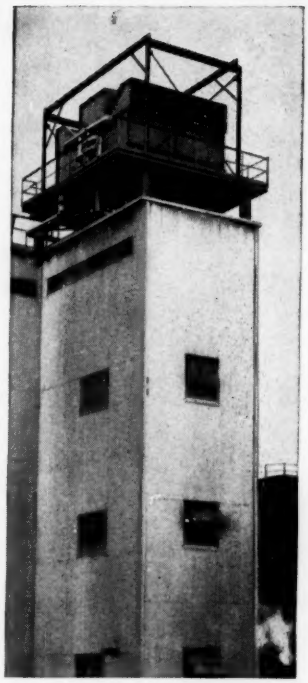
Pumps, Fans, Compressors

Air Intakes.....Dimensions, performance data, photographs of equipment, conversion factors, all included in this 12-page brochure on fans and heating equipment.
218b Hartzell Propeller Fan Co.

Compressors.....Information on how you can plan compression and power facilities is available. Also a bulletin, "Cooper-Bessemer Equipment for Chemical Plants."
22-23 *Cooper Bessemer

Compressors.....Special purpose single-stage centrifugal compressors all detailed in Bulletin P-13. Section on data and sample performance calculation included.
220a Elliott Company

* From advertisement, this issue



Trustworthy "CLOSED-CIRCUIT" Cooling

holds temperatures to close limits in entire processing column

● This Niagara "Aero" Vapor Condenser produces constant temperatures, assures sustained capacity to this fractionating column, holding production and quality uniform. A closed system, it avoids fouling troubles, holds temperatures within specified limits at all points.

It gives a higher vacuum than conventional type condensers, effectively separating the non-condensibles at the condensate outlet, with sub-cooling after separation.

It produces this higher vacuum with use of less steam and power. It holds its full capacity with only a nominal consumption of water, using air as the cooling medium. It answers the question of water supply or disposal.

Mounted directly on the steel structure of the evaporator or distillation column, installation is simple, operation is dependable, maintenance is neither troublesome or expensive. For description and capacities write for Bulletin 129.

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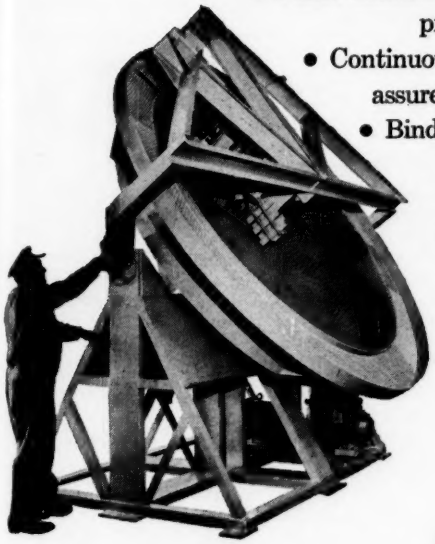
DRAVO DISCS
offer these plus values for pelletizing and mixing . . .



- Pellet uniformity is far superior to that produced by other methods.
- Continuous operation (not batch) assures higher production rates.
- Binder is unnecessary in many cases.
- Low overall cost per ton of output.
- Material in process can be viewed continuously.

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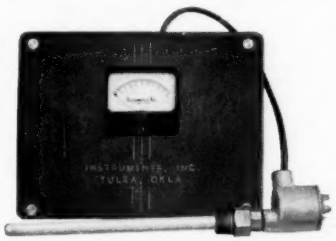

ELECTR-O-LEVEL is used NOW on polyethylene levels; aluminum ore levels; pulverized refractory levels; liquid oxygen; raw sugar levels; liquid nitrogen and jet fuel.

WRITE FOR BULLETIN L-1053

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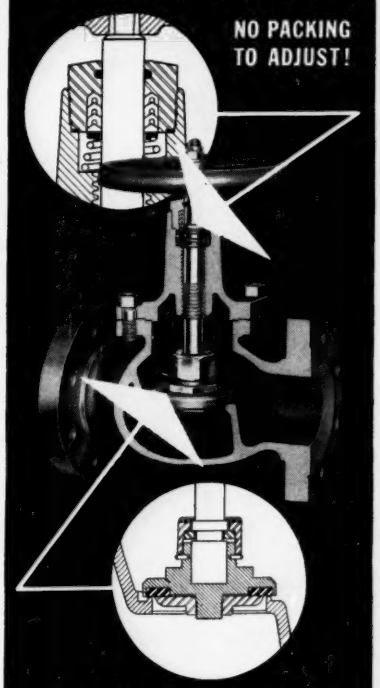

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4. **Dust Trap assures efficient dust removal from the cone**
5. **Vortex Shield prevents re-entrainment of dust in upward gas vortex**
6. **Scroll Outlet provides a low resistance clean gas outlet**

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the name in DUst CONtrol

THE **Ducon** COMPANY, INC.

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LITERATURE . . .

Compressors.....The WGO-9 supplies air free of contamination because it uses no lubrication in the cylinder. Capacities run from 95 cfm-15 hp, to 939 cfm-75 hp. Bul. 337-11.
159 *Joy Mfg. Co.

Compressors, Centrifugal.....Features a design, using advanced aerodynamic concepts and space-age metallurgy, which results in trouble-free service. Bulletin 1491-11.
161 *Joy Mfg. Co.

Fan.....New design duct fan by De Bothezat has removable cone design. Pull fan wheel or motor while Bifurcator Fan remains in duct. Descriptive literature.
210 *American Machine & Metals Inc.

Pumps.....A full cross-section drawing and detail drawings and diagrams bring out the features of this line of low head submerged pumps, now available for draining.
220b U. S. Electrical Motors Inc.

Pumps.....Complete information on capacities, pressures and sizes. Ability to solve pumping problems of the process industries. Reprint (Data Sheet 100) offered.
149 *Aldrich Pump Co.

Pumps.....Durcopumps are available with heads to 345 ft. & capacities to 3500 g.p.m. Built specifically for pumping sulfuric acid solutions. Bul. P-4-100.
163 *The Duriron Co., Inc.

Pumps.....Series 200 Metering Pump has 6 stroking speeds, several plunger diameters. Bases in steel plate, pipe or structural shapes. Up to 4000 psi in lower ranges.
172 *Wallace & Tiernan Inc.

Pumps, Acid.....In a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. 1" to 8" discharge sizes with 10 to 3000 GPM.
235 *A. R. Wilfley & Sons, Inc.

Pumps, Centrifugal.....Catalog contains photos & performance charts for the Centrifugal Fuel Transfer Pump & Centrifugal Cryogenic Transfer Pump series.
220c The J. C. Carter Co.

Pump, Vacuum.....Complete information about the new Series H Microvac pump is available. Also a free vacuum slide calculator is offered to you.
L218 *F. J. Stokes Corp.

Services & Miscellaneous

Application Research.....Assistance on problems of metals application such as corrosion, cryogenics, abrasion, etc. Also Clad Steel Equipment Bulletin No. H-90.
147 *Lukens Steel

Atomic Energy.....This booklet has been prepared to broaden popular understanding of the impact atomic energy is having and will have in the future on our economy.
220d Allied Chemical Corp.

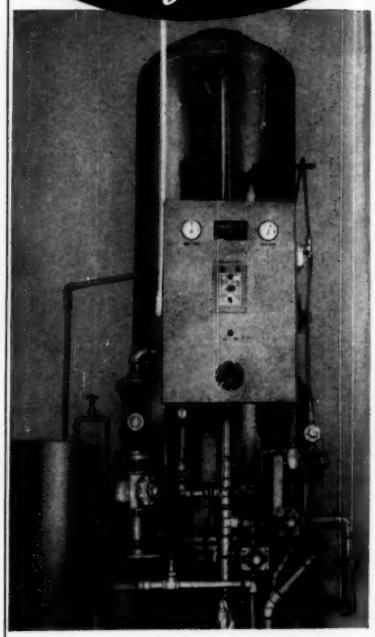
Casters & Wheels.....Have many advantages such as rubber treads and string guards. Rust-proofed by zinc plating. Full story given in Manual.
L191 *Darnell Corp., Ltd.

* From advertisement, this issue

Need Ultra-Pure Process, Make-Up or Rinse Water?

Check the pioneer maker* of "Packaged" Demineralizers

Penfield



- **Purity in excess of 15-meg ohms** — where you need it, in the quantities you need.
- **Fully Automatic Operation** — set one switch to accomplish entire regeneration cycle.
- **Shipped Completely "Packaged"** — each unit is ready to operate when you receive it.

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LITERATURE . . .

Casting Process.....A new 56-page brochure shows the industrial applications of a new casting process with photos from plants using some form of the casting process.
221a Shaw Process Development Corp.

Construction.....All plants tailored to particular commercial and technical requirements for first cost, feed stock, yield, product purity, operating cost. Information.
71 *Foster Wheeler Corporation

Cryogenics.....New applications of cryogenics leading to improved production efficiency and more profitable operations. Free brochure available on request.
L189 *American Messer Corp.

Drafting Kit.....A catalogue features portable drafting kits which contain drawing boards, T-squares, triangles and protractors in a vinyl-covered attache case.
221b Retake Inc.

Fasteners.....Bolts, studs, screws, nuts, washers, rivets, pins, in many ranges, head styles, etc. Full specifications in catalog available on request.
221c Albany Products Co., Inc.

Pollution.....A 16-page illustrated booklet describes the work done by New York University in air and water pollution in the last 10 years and work proposed.
221d New York University

Process, Metal.....InFab (Inert Fabrication) is a new process which was conceived and constructed for the production of high integrity mill products from refractories.
221e Universal-Cyclops Steel Corp.

Quartz, Fused.....For ultraviolet transmission applications, laboratory ware and production equipment.
155b *Engelhard Ind. Amersil Quartz Div.

Research.....This company's quarterly publication reports research currently being done and research completed, and carries abstracts of its U. S. patents.
221b Engelhard Industries, Inc.

Success and/or Happiness in Engineering.....Booklet giving facts-of-life for successful engineers. Deals with self-appraisal, vision, respect, etc. Free copy available.
R213 *Western Supply Company

Turrets.....Fire-Fighting Turrets discharge FogFoam, Solid Foam Stream, WaterFog, Solid Water Stream. Full details on the complete line of fire-fighting products.
96 *Rockwood Sprinkler Co.

Water Treatment.....Four new booklets are available on the topics of recirculating cooling and process water selection of treatment and polymetallic systems.
221g Nalco Chemical

Welding Alloys.....A 148-page, maintenance welding data book provides a guide, indexed by application, to 200 different welding rods, etc.
221h Eutectic Welding Alloys

* From advertisement, this issue

EMPLOYMENT OPPORTUNITIES

(Continued on following page)

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CHEMICAL WEEK
330 W. 42nd St.
New York 36, N.Y.

Equipment Searchlight

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now

FOR "IMPOSSIBLE" BUDGETS

1—Sharples H 1½ Continuous Auto. Centrifuge. S.S. bowl 7½ HP

5—Lee 150 Gal Stainless Steel Jacketed Kettles

2—Lee 350 Gal. S.S. Tank with Stainless coils

1—Sperry 36" Filter, 26 wood frms, 25 plts. Hydro Closing

3—Downington 52 sq ft type 316 Shell & Tube Heat Exchangers

1—6' x 35' Dryer, ½" riveted shell. 15 HP drive w/reduction

2—6' x 50' Dryers, ½" riveted shell. 20 HP drive w/reduction

1—8' x 40' Dryer, ½" riveted shell. Inter-cellular constr.

For immediate quote, wire or phone collect—GA 1-1380

ME MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. · San Francisco 7, California

CIRCLE A ON READER SERVICE CARD

IMMEDIATE DELIVERY

MIXER: Baker Perkins size 17 200 Gal., W & P 20-Gal. J. H. Day 75 Gal. 50-Gal: W. & P. DBL. NABEN Blade.
TANKS: 1,500 Gal. totally enclosed 15 PSI Int. 3,800, 4,500 and 6,500 Gal. S/S lined. 1,000 Gal. Totally Inclosed.
MILLS: Fitzpatrick Mod. D 6 S/S; Mikro 2TH. Prater 009; Rietz Disintegrator Mod. RD 18 P.
HEAT EXCHANGERS: Foster Wheeler from 79 to 520 sq. ft. heating surface, type 316 S/S tubes & crown sheets. Priced to sell.
CENTRIFUGE: Tolhurst 20", type 316 S/S Hydraulic Drive.

AARON ARECO EQUIPMENT CO
9370 Byron Street
Schiller Park, Illinois
Gladstone 1-1500

CIRCLE B ON READER SERVICE CARD

STAINLESS STEEL TANKS

24" x 45", 10 gauge, 400 PSI, type 304, ¼" pipe thread each end. NEW, $300 value, $99.50. Size 8½" x 18", 16 gauge, $14.50. Case of 8, $14.25. F.O.B. Baton Rouge, Louisiana.

Illinois Mfg. & Supply Co.
1829 S. State, Chicago 16, Illinois

CIRCLE C ON READER SERVICE CARD

Equipment Wanted

DRYER—Continuous Apron Conveyor type. Total drying area approx. 250 sq. ft. Apron construction, stainless steel.
HAMMER MILL—#3 Mikro or equivalent.
MIXER—Double arm, blade tilting type. 300 gal. working capacity. Steam jacketed. 40 H.P. Stainless steel construction.
ROTARY AIR LOCKS—8"—12".
BALL MILL—6' x 10' Jacketed. Chrome Manganese Steel.
STAINLESS REACTOR—Min. size 6'6" x 8'. Must be built for 100 PSI pressure.
3 STAINLESS STEEL CONDENSORS—200 to 400 sq. ft. of tube surface.

Please include price information with full particulars in the first letter. Indicate if you own the equipment and where it is available for inspection.

W-4919, Chemical Engineering
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

CIRCLE D ON READER SERVICE CARD

DIESEL LOCOMOTIVES & CRANES

9 Gen. Elec. 20, 25, 45, 65, 80 & 100-Ton
25-Ton Industrial Brownhoist, 60' Boom Crane

PLANT EQUIPMENT

4' Telsmith TY Gyratory Crusher
2—Womco 2M-HMS Plants
No. 5000 Dixie Mogul Hammermill 500 HP
No. 1 Sturtevant Rotary Fine Reduction Crusher
72" x 28' Madison Rotary Dryer
F55 Syntron Grizzley Feeder
10—1½ & 2 Yd. V-Shape Dump Cars
2—5' x 8' KVS Air Swept Ball Tube Mills
Ball Mills: No. 56, 6' x 4', 6' x 9' & 7' x 22'
Hardinge Mills: 3'x8", 3'x24", 6'x48" & 10'x48"
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 10" x 20", 14" x 28", 15" x 24", 30" x 36", 48" x 72" & 56" x 72"
Crushers, Fine Reduction: 22", 2', 3', 5½' 848 Cone, & 40" x 22" Roll
Rotary Dryers: 3'x30', 5'x30', 6'x70' & 8'x80'
Rotary Kilns: 36" x 30', 6' x 70' & 9' x 160'
Roto Louver #207-10 Type 316 SS, Link Belt
Louisville Monel Steam Tube Dryer, 54" x 35'
Laboratory Rotary Kiln, 36" x 30', Complete
4' x 10' Tyler-Hummer Electric Vibrating Screen
3' x 12' Seco Single Deck Vibrating Screen
8' x 16' Gayco Centrifugal Air Separator
24" x 95' Hewitt Robins NEW Truss Belt Conveyor
6—30" x 32" Dings Magnetic Head Pulleys
3—Inger.-Rand 2200 & 3051 CFM Compressors
2000 Tons Steel Sheet Piling, 10' to 78'
2—150 HP, 1—200 HP S.D. Elec. Hoists

WANT BUY DRYERS — KILNS — CRUSHERS

R. C. STANHOPE, INC.
60 E. 42nd St. New York 17, N. Y.
Tel. MU. 2-3075

CIRCLE E ON READER SERVICE CARD

SEPTEMBER SPECIALS

Abbe 5' x 6' J'ktd. Ball Mill, chrome mang. steel
2 Oliver Rotary Vac. Filters, 3' x 2', 63" x 8'
3 Bird Filters, 18" x 28", 4' x 1' & 24"
Ribbon Blenders, Steel & SS, all sizes, New & Used
Gen. American 42" x 120" Twin Drum Dryer
Gruendler "BB" Hammermill. Whirlbeater
Day #4 gearless 80 gal. Pony Mixer, 10 hp.
Pfaudler 1500 gal. glass enclosed top Tank
Colton # 5½ Preformer, max. size 3" x 2⅛" tablet

WHAT HAVE YOU FOR SALE OR TRADE?

YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, Inc.
111 33 Street Brooklyn 32, N. Y.
SOuth 8-4451—4452—8782

CIRCLE F ON READER SERVICE CARD

BRILL FOR VALUES

CENTRIFUGES

Sharples C-20 and C-27 Super-D-Hydrator, 316 S.S.
Bird 18"x28", Solid Bowl, Continuous, 304 S.S.
Bird 32" x 50", Solid Bowl, Continuous, 316 S.S.
Sharples PY14, PN14 Super-D-Canters 316 S.S.
Tolhurst 26" susp. Rubber Imperforate Basket.
Fletcher 48" Suspended 316 S.S. Perforated Basket.
Sharples #16, 304 S.S., 3 HP motor.

REACTORS, EVAPS, ETC.

2—Glascote 750 gal. glass lined jacketed Reactors.
1—1200 gal. S.S. Jacketed Kettle.
650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
1400 gal. Blaw-Knox, steel, jacketed, agitated Reactor.
1—700 sq. ft. Buflovak 304 SS Forced Circulation Evaporator
550 sq. ft. Buflovak monel single effect Evaporator
7500 gal. 316 S.S. Vert. Storage Tank, 7'x25', 50 psi.
750 gal. nickel clad Mixing Tank, 125# nickel coils.
500 gal. 304 S.S. Mixing Tank with nickel coils.
6—7,500, 6,000 and 2,000 gal. Rubber Lined Tanks.
4000 gal. Haveg Vert. Tank 8'x12'.
7500 gal. Rubber Lined Tanks 10'x13'.
1500 gal. Stainless Pressure Tank, 5'x10', 90#.
12,000 gal. horiz. steel Pressure Tank, 7'6"x36', 200 psi.
Stainless Heat Exchangers; 1220, 786, 536, 370, 315, 250 sq. ft.
Falls Industries 100 sq. ft. Karbate Condensor.
24" dia. x 35', 304 S.S. Bubble Cap Column.

FILTERS

#5 Sweetland Filter 304 S.S. 120 sq. ft.
Oliver 6' dia. Horizontal Filter, 316 S.S.
Oliver 5' x 6' Steel Rotary Vacuum Precoat Filter.
U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
Oliver 5'3"x8' Steel Rotary Vacuum, vaportite housing.
Oliver 3' x 2' 347 S.S. Rotary Vacuum Filter.
Feinc 5'x6' Stainless Steel Rotary Vacuum Filter.
#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

DRYERS

Buflovak Vacuum Shelf with 20—60"x80" shelves.
1—4' dia. 304 SS Spray Dryer.
Devine Vacuum Shelf with 19—59"x78" shelves.
Devine Vacuum Shelf with 10—40"x43" shelves.
Buflovak 42"x120", atmospheric double drum Dryers, complete.
Devine 4'x9', single drum, atmospheric.
Buflovak 3'x10' Rotary Vacuum Dryer.
Baker Perkins 5'6"x6" Rotary Vacuum Dryer.
Buflovak 5' x 30', 3' x 7'6" Rotary Vacuum Dryers 316 S.S.
Louisville Rotary Steam Tube 6'x25', 6'x50'.
Louisville 8'x50' Stainless Steel lined Rotary Dryers.
Rotary Dryers 34"x30', 4'x40', 6'x50', 6'x60', 7'x80', 8'x87'.
Traylor 30"x18' Stainless Steel Rotary Dryer.
Link Belt, 7'5"x25', 6'4"x24", S.S. Louvre Dryers.
Atmos. Tray Dryers, 16 shelves, 40"x24".
P&S 10' wide Apron Conveyor Dryer 48' long.

MIXERS

1—Farrell-Birmingham "Midget" Banbury Mixer.
Day Imperial 150 gal. jktd. double arm.
Baker Perkins 100 gal., jacketed, double arm, 30 HP.
Baker Perkins #16TRM, 150 gal. jktd., Vac. 60 HP.
Baker Perkins 50 gal. jacketed, double arm.
Baker Perkins 10 gal. Jacketed 304 SS double arm.
Day "Cincinnatus" double arm, 250 and 100 gal.
Steel jacketed Powder Mixers, 225 and 350 cu. ft.
Patterson 6' dia. Conical Blender 15 HP.
3' dia. Simpson Intensive Mixer.

MISCELLANEOUS

Farrel Birmingham, 8" x 16", 2 Roll Chrome Plated Mill.
ISH, ISI Mikro, Pulverizers, 3 HP.
Abbe 2½'x3' porcelain lined Pebble Mill XP motor.
1—Raymond 10' dia. Single Whizzer Separator.
Raymond 10' dia. Single with Separator.
#5 Mikro Atomizer with motor and cyclone.
Bantam Mikro Pulverizers, S.S.
No. 1 Ball & Jewell Rotary Cutter.
#18 Cumberland Rotary Cutter.
Swenson Walker Continuous Crystallizers, 24"x30' sections.
#24 Rotex Sifter, 20" x 64", Quadruple deck.
#22 Rotex Sifter 40" x 56" double deck.
#81 Day Roball Sifter 40" x 120" single deck.
Chlorimet, Durimet and Duriron Centrifugal Pumps 1½" to 6".

Partial List — Send for Complete Circular
Ask About Our Rebuilding Services
TEXAS OFFICE: 4101 San Jacinto Street, Houston 4, Texas — Tel.: JAckson 6-1351

BRILL EQUIPMENT CO.
35-61 Jabez St., Newark 5, N.J.
Tel.: MArket 3-7420

CIRCLE G ON READER SERVICE CARD

MORE CHOICE STAINLESS EQUIPMENT THAN ANYBODY

2 STAINLESS 30" MICRONIZERS COMPLETE WITH ACCESSORIES

MIXERS—ALL TYPES

Readco Jktd. Stainless Steel Dbl., Arm Mixer; 15 gal.; 15 HP.
C-3-4—Two Lehmann Amalgamators; Stainless Lined; 32" x 44" x 36"; Stainless Arm; 7½ HP.
F4—Stainless Steel Double Arm Vacuum Mixer; 150 gal.; 44" x 44" x 36" with cored blades; 40 HP Motor.
B1—J. H. Day Cincinnatus Stainless Steel 300 gal. Jacketed Double Arm Mixer.
F1-2—Stainless Lined Double Sigma Vacuum Mixers 300 gal. 56" x 50" x 44"; with 60 HP Motors.
Patterson-Kelly Stainless Twin Shell Blender; 30 cu. ft.

REACTORS—VACUUM PANS

D2—Vertical Stainless Deaerator Tank; 18" x 48" Jktd.; good for Full Vacuum; cone bottom.
Stainless Steel 60 gal. ASME Reactor; 20" x 34"; coil heated.
M13—Stainless Lined 60 gal. Reactor 22½" x 34" with Stainless Coils and Agitator.
H5—Stainless Lined Vertical Pressure Vessel 4' x 4' dished heads; 24" manhole; Internal Heating Coil.
T5—Patterson-Kelley Stainless Steel Percolator or Extractor 200 gal. 28" x 76"; ASME coded.
Struthers-Wells Stainless Steel Reactor Jacketed 400 gal.—Agitated 7½ HP.
Patterson Foundry STAINLESS Reactor; 400 gal. Jacketed 30#; 30# Int. ASME; Agit.
Lancaster Stainless Lined Rotary Reactor; Jktd; 50" x 17'4" 300 PSI internal.
Mojonnier Stainless Vacuum Pan 3' x 10'.
Mojonnier Stainless Vacuum Pan; 6' x 12'; Vertical Counter Current S.S. Condenser; 261 sq. ft.

EVAPORATORS—KETTLES—TANKS

Zaremba Double Effect INCONEL Evaporator with calandria; 430 sq. ft. of surface; with accessories.
M2—Mojonnier 3' dia. S/S Calandria Evaporator; 30.5 sq. ft.
S5—Vertical Stainless Lined Mixing Kettle 40 gal. 24" x 21" with Stainless Heating Coils and Agitator.
S6—Stainless Lined 100 gal. Mixing Kettle; 32" x 30" with 6 turns of S/S Heating Coils and Agitator.
Brand NEW Stainless Steel Kettles good for 100# always in stock; sizes up to 500 gal.
Stainless Steel Vacuum Still; Coil Htd. 755 gal. 4'6" x 6'; with Aluminum Column.
Electrically Heated 800 gal. Stainless Steel Kettle 60" x 60".
Stainless Steel 500 gal. Vertical Jacketed Agitated Kettle 48" x 67".
Stainless Vertical Kettle 5' x 8'9", 1300 gal. set in a cooling jacket.
Struthers Wells Type 316 Stainless Vertical Mixing Kettles, 2000 gal. 6' x 10' Jktd. and Agitated.
Two Plaudler Stainless Steel Jacketed Evaporating Dishes; 6' x 30".

DRYERS—ALL TYPES

Bowen Stainless Steel Spray Dryer; Table Model; 30" x 32".
Nickel Plated Drying Drums 4' x 4'.
Type 316 Stainless Drying Drum; 32" x 52".
Stainless Lined Rotary Counter Current Atmospheric Dryer; 50" x 20' with Oil Burner, Combustion Chamber, etc.
Louisville Stainless Rotary Dryer 30" x 28'; Ind. fired.
Jacketed Rotary Dryer or Roaster; 42" x 12'; Monel shaft and Blades.
Louisville MONEL Rotary Steam Tube Dryer; 54" x 33'.
Two Stainless Concentrators; each has Bank of 4 Rotary Vac. Continuous Jacketed Dryers, 2' x 10'; 20 HP.

FMC Pays More For Your Surplus

FIRST MACHINERY CORP.
209-289 TENTH ST.
BROOKLYN 15, N. Y.
STerling 8-4672

CIRCLE H ON READER SERVICE CARD

CHEMICAL EQUIPMENT DIVISION

RAYMOND 5057 HI SIDE 5 ROLL MILL.
FAN, SEPARATOR, CYCLONE, & MOTORS.
Raymond 3 Roll #3036 Hi-Side Mill
Buflovak 18 Shell Vacuum Shelf Dryer
1000 sq. ft. Stainless Heat Exchangers (2)
Tolhurst 40" S.S. Center Slung Centrif.
Fletcher 40" Susp. Steel Centrifugal
Sweetland #12, #10, #7 Filter Presses
30 Gal. S.S. Jktd. Autoclave 1000 PSI Int.
Shriver 30"x30" P&F 36 C.I. Chambers
Nooter 750 gal. Steel Reactor 300 PSI
Traylor 8' x 11' Ball Mill
Allis-Chal. 8'x60'x3½" Welded Rotary Kilns
Vulcan 6'x124'x1½" Rotary Kiln
Link Belt 502-16 Roto-Louvre Dryer
8' x 80' Rotary Dryer 316 S.S.
4' x 47' & 4' x 30' Rotary Dryers
Louisville 6'x50'; 6'x25' Steam Tube Dryer
Condensers 100 to 5000 sq. ft. Steel; Admir.
Dixie #5060 Mogul Hammermill
Raymond #50, #40 Impact Mills

SEND US YOUR SURPLUS LISTS

HEAT & POWER CO. INC.
60 E. 42nd St., New York 17, N. Y.
310 Thompson Bldg., Tulsa 3, Okla.

CIRCLE J ON READER SERVICE CARD

AGITATOR—S/S w/10 HP xpl. proof 2 spd motor, 3" shaft x 6' long w/propeller—1 HP Lightnin' 1150 RPM

SCREENS—12" x 72" S/S Ajax—20 x 84, 20 x 96 Rotex—3 x 5, 3 x 10 Tyler Hummer

FEEDERS—S/S Vibrating 4½ x 24, 24 x 72 Syntron—Hardinge B Constant Weight

MILLS PULVERIZING—3 HP Sturtevant 00—10 HP Mikro 2 TH—30 HP Raymond—50 HP Mikro 3 TH w/Mikro Collector (unused)—100 HP Jeffrey 36 x 42—250 HP non-clog—450 HP Penna. SXT 14.

DRYERS, ROTARY—24" x 22', 3' x 24', 4' x 40', 5' x 50', 6' x 30', 7' x 58' all w/motor drives

DRYER, VACUUM SHELF—w/13 shelves 59" x 78", total area 356 sq. ft.

BRIQUETTING MACHINE—Komarek Greaves, 11/16 x 4-5/16 x ¼" dies w/feeder, motors, etc.

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE K ON READER SERVICE CARD

LOEB OFFERINGS

Autoclave: 50 gal. Struthers Wells, st. st.
Centrifugal: Tolhurst 20" st. steel (New).
Centrifugal: AT&M 60" st. st. perf.
Dewaterers: Davenport 3A, bronze hd. 3 hp.
Disintegrator: Rietz RD18F, 75 hp.
Dryers: Devine 2 x 4' vac. drum, st. steel.
Dryer: Bowen lab. spray, st. steel.
Dryer: American atmospheric 24 x 48".
Dryer: Devine #7 13-shelf 60" x 7'.
Dryer: Stokes vac. shelf 22—44x40".
Evaporator: Buflovak st. st., 94 sq. ft.
Filter: Sweetland #5 st. st. lined.
Filter: Oliver precoat 12 x 2" st. steel.
Filter: Elmco st. st. drum 16" x 12".
Filter Press: Shriver 24" St. steel.
Heat Exchangers: 400 sq. ft. st. st. tubes.
Homogenizers-Dispenser: Tri-Homo #10, #4.
Kettles: st. steel with and without ag.
Dopp 150 gal. dbl. act, agitator.
Mills: Mikro Atomizer 5MA, st. steel.
Day 3-roll high speed 14 x 30".
Mixers: Dbl. and sgl. arms sigma blade.
Dry Powder, various sizes.
Pumps: Rotary, gear, centrif., vacuum.
Screen: Rotex model 41 st. steel.
Tablet Press: Stokes DD2, 23 station.
Vacuum Pans, 42" and 72" stain. steel.

LOEB EQUIPMENT SUPPLY CO.
TELEPHONE SEeley 8 1431
820 WEST SUPERIOR ST. CHICAGO 22 ILLINOIS

CIRCLE L ON READER SERVICE CARD

COMPRESSORS

No better values at any price

74 CFM	1500 PSI	6¼-3¾-1⅝x7 CP. TCB3
100 CFM	150 PSI	6x7 Ing. ES-1
104 CFM	2500 PSI	6¾-4¼-1-11/16x9 IR-ES3
110 CFM	3000 PSI	Ing. GC 50BW
138 CFM	100 PSI	7x7, Ing. ES, CP & Joy
151 CFM	3000 PSI	13¾x12 Norwalk TRS-4T
288 CFM	100 PSI	9x9 Ing. Worth, CP
311 CFM	1500 PSI	10½-7⅛-3⅛x13 IR-ES3
351 CFM	350 PSI	11-8x11 CP TCB-2
401 SCFM	350 PSI	IR ES8H2 (New) 12-6x11
465 CFM	100 PSI	12x11-IR-ES CP.T. Worth HB
660 CFM	125 PSI	11¼-7x7 Joy Wn 102
686 CFM	100 PSI	14x13 Ing. ES-Chic. P.T.
877 CFM	125 PSI	17-10½x14 IR. XRB
1665 CFM	(actual) 100 PSI	C300-300H Fuller
1721 CFM	110 PSI	23-14x16 Ing. PRE2
2950 CFM	100 PSI	19x30x30x19x24 Ing. XPV

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N.J. UNion 5-1397

CIRCLE M ON READER SERVICE CARD

OVER 5,000 MACHINES IN STOCK

FOR EVERY INDUSTRY AND PURPOSE

- Wrappers
- Packaging machines
- Cartoning machines
- Fillers
- Labelers
- Filter presses
- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

TELL US YOUR REQUIREMENTS

Complete Details And Our Special Low Bargain Prices Available On Request

UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N. Y.
Phone: Canal 6-5333-4-5-6

CIRCLE N ON READER SERVICE CARD

Baker Perkins 150 gal 40 HP, 100 gal 50 HP. Both S.S. 2 arm jacketed vacuum hdr. tilt.
Aluminum Condenser 350 sq ft.
Aluminum Evaporator Calandria type, never used. 1300 sq feet tube area.
Continuous Stripping column 2 x 13 Steel.
Hydraulic Pumps & Motors.
Dryers Vacuum Shelf.

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

CIRCLE O ON READER SERVICE CARD

P	2,000,000 ft. 2"	3.50# to the foot	P
I	1,000,000 ft. 3"	7.70#	I
P	1,000,000 ft. 4"	10.98#	P
E	500,000 ft. 6"	19.80#	E
	200,000 ft. 8⅝"	28#	
	400,000 ft. 10¾"	35#	
	75,000 ft. 12¾"	40#	

All No. 1 Grade Plain End and Cleaned
INDIANA-OHIO PIPE CO.
P.O. Box 5412 Sheppard Sta. Phone CL 3-5527
COLUMBUS 19, OHIO

CIRCLE P ON READER SERVICE CARD

FOR SALE
JACKSON & CHURCH AUTOCLAVE
Vacuum Impregnator—Jacketed
54" x 72"—150,000 Cu. Inch
Almost New
GLOBE TRADING COMPANY
1815 Franklin St. Detroit 7, Mich.

CIRCLE Q ON READER SERVICE CARD

BEST BUY

6 x 7 x 60' long Rotary Flame Dryer. Complete with fire-box Motor drive, Fans & Cyclones. Extra heavy insulated shell.

Excellent Condition

Wire or phone collect—GA 1-1380

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. - San Francisco 7, Calif.

CIRCLE R ON READER SERVICE CARD

PUBLIC – AUCTION – SALE

By Order of The Board of Directors—Due to Consolidation of Facilities

Rubber Making Machinery & Equipment and Valuable Real Estate Of The

NEW YORK RUBBER COMPANY, BEACON, NEW YORK

SALE DATE: Tuesday, September 20th, 1960—Starting at 10:00 A.M. (DST)

INSPECTION: September 13th to Sale Date.

COMPRISING

(12) RUBBER MIXING MILLS

2 lines of three 18"x50" Farrel Birmingham, each line coupled to 250 HP motor & reduction drive unit.
2 lines of two 22"x60" Farrel Birmingham, each line coupled to 125 HP motor & reduction gear unit.
1 line of two 20"x60" Vaughn, coupled to Helical speed reducer & 150 HP motor.

(3) CALENDERS

54" Farrel Birmingham 3-roll calender, complete with gear reduction unit & direct coupled motor.
60" Farrel Birmingham 3-roll calender, complete with gear reduction unit & direct coupled motor.
66" Farrel Birmingham 3-roll calender, complete with gear reduction unit & direct coupled motor.

CONVEYOR BELT PRESSES

4 Farrel Birmingham hydraulic, 2 platen steam presses, (1) 52"x26' with 12 hydraulic rams; (1) 62"x21' with 20 hydraulic rams; (1) 43"x25' with 6 hydraulic rams; (1) 65"x25½' with 24 hydraulic rams.
Farrel & Southwark multiple platenhydraulic curing & vulcanizing presses.
5 platen steam press 66"x48".
2 Farrel 2-steel roll belt press 38"x7" rolls; 1—60"x12" diameter rolls.

LABORATORY EQUIPMENT: Fully equipped laboratory.

TUBERS: #1 & #3 Royal direct motor drive.

CUTTERS & SLITTERS: 42" Black Rock hydraulic cutter, Eastman knife cutter; Farrel 64" knife slitting machine with 18 adjustable knives; miscellaneous belt cutting & inspection machines; Camachine 82" power slitter; Beltmaster 56" portable cutting machine; NYR 2-steel roll belt cutting & inspection machines, 64" roll, 30' table.

COATING MACHINES: 4 Barry 1953 coating machines, 72" wide; 72" roll Doubler; Sterling dusting & blower unit; 9 American & Berry tank cement churns, 200 gal. capacity; (4) Day & Ross motor driven paint mixers.

MISC. RUBBER EQUIPMENT: Quantity of winding and rewinding units motor driven, Singer sewing machines, bench type vulcanizers, 72" Van Vlanderen beamer, Curtiss brush units, V belt roll die machine, endless belt curing unit, buffing machines, lead lined testing tank.
COMPRESSORS & PUMPS: 50 HP Gardner Denver compressor 6½x5½; Binks single stage, Worthington Y type 5 HP motor; centrifugal & monobloc pumps, (2) Worthington vertical hi pressure pumps 30 HP motors, 40 HP Gould water pumps, etc.

COMPLETE MACHINE SHOP: Lathes, millers, saws, shapers; woodworking equipment, i.e., saws, borers, etc.; complete Cafeteria; factory handling equip., i.e. 2-ton Clark hydra-tork car loader, Clark fork lift; Chevrolet, International Ford, Studebaker trucks; large assortment of chain & electric hoists up to 3-ton; overhead tramrail system.

OFFICE FURNITURE & EQUIP.: Tremendous asst. of office equipment including walnut executive desks, chairs, & tables; National bookkeeping machines, (13) I.B.M., Royal, Remington typewriters; (10) Marchant, Monroe electric calculators; mimeograph, addressograph; dictaphones, etc., and hundreds of other items.

REAL ESTATE

185,000 Sq. Ft. of Valuable Industrial Real Estate located on approx. 6⅓ acres, situated on the west side of Fishkill Creek, with valuable supply of water available on the property. (3) Extremely modern buildings built in 1942, single story cinder block construction, each with 50,000 sq. ft. of space, clear span heavy floor loads; railroad sidings throughout the plant serviced by Central Northeast Railroad; oil fired boilers; cafeteria facilities; excellent labor supply in the area of this valuable industrial property.

REAL ESTATE WILL BE SOLD AT 12, NOON, PROMPTLY

For Descriptive Brochure **WRITE—WIRE—PHONE**

For Top Dollar Realization

INDUSTRIAL PLANTS CORPORATION

America's Foremost AUCTIONEERS

90 West Broadway, New York 7, N. Y. • BArclay 7-4185

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CIRCLE 5 ON READER SERVICE CARD

Chemical Manufacturing And Handling Equipment

USED EQUIPMENT—EXCELLENT BUYS

FOR SALE

Boiler, ECLIPSE Scotch Marine, 50 HP, 145#, gas or oil, used 6 months

Gas Converter, GENERAL ELECTRIC, G5, 4000 CFH, 400°F., 125#

Lectrodryer, PITTSBURGH Size 750, Type BWC, 100# W.P.

Drycolene Producer, GENERAL ELECTRIC, 2000°, 200 cu. ft., Type G2

Impregnator, 21" diameter, 11" deep, combination impeller and spinner

Screen Vibrator, J. H. DAY, 50" x 116"

Hammermill, swing hammer type, 4½" x 16" opening, 25 HP

Hammermill, swing hammer type DIXIE, 24" x 40" opening, 25 HP

Hammermill, McKAIN, 12" x 12" opening, 5 HP

Tablet Machine, New STOKES RD3X, 13/16" die, 7 ton

Tablet Machine, COLSON Model 1035, 1", 35 station

Colendria Pan, 11'8" diameter, 13' high with vacuum pump

Stainless Tank, 42" diameter x 60" high, 10 gauge bottom discharge

Tanks, vertical and horizontals, 7500-8000 gallon

Acid Proof Bronze Pressure Vessels, 42" x 72", 125# pressure

Mixer, BAKER PERKINS, 36" x 84" opening, 100 HP

Mixer, SIMPSON, 36" diameter tub, 5 HP

Mixers, SIMPSON #3, 8' diameter pan, intensive type, with elevators, 1942 (4)

Front End Loader, OLIVER ½ yd. Caterpillar tread

Front End Loader, LORAIN Moto-loader, 15 cu. ft., bucket, pneu. tires—New

Separator, RAYMOND Single Whizzer Type

Dust Collector, AMERICAN Rotoclone, 5250 CF

Extractor, TOLHURST, 48", 7½ HP, 40 HP

Hydraulic Pumps—all sizes to 213 GPM, 1800# pressure

Blowers, CONNORSVILLE Positive Pressure—all sizes

Crane, Model 83 BYERS, ⅝ yd., 38' boom, diesel, magnet, controls, and generator, 1947

Crane, Model 25 NORTHWEST, ¾ yd., 35' boom, diesel

Crane, Model 79 LORAIN, 1¾ yd., 60' boom, diesel

Crane, OHIO Locomotive, 30 ton, 8-wheel, diesel, 50' boom, outriggers, generator, new 1954—LIKE NEW CONDITION.

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Telephone: WOodland 2-7721

CIRCLE T ON READER SERVICE CARD

BUFFALO 32"x90" DOUBLE DRUM DRYER

DAY HY-R SPEED MILL

Centrifugals: 12", 30", 40" & 48".
Centrifuges: Sharples #5 & #6 Stainless.
Dryers: Hersey 5'x26' Rotary, 316 Stainless
Buffalo Vac. Drum Dryer 24"x20".
Despatch Ovens Elec. Heated.
Devine Vac. 8 shelf Dryer 38" x 42".
Hope Stainless Can Filler pts. to gals.
Filters: Vallez 49 S. S. covered leaves.
#2 Sweetland 12 Stainless Leaves.
Filter Presses: 6" to 36" Iron & Wood.
Kettles: S.S. Jack 20 to 500 gals.
Dopp 350 gal. cast iron Jack. Vacuum.
Devine Impreg. Units 30" & 36" dia.
Mills: Raymond #00, 30 HP. & #0000.
Mikro Pulverizers #4, 2, 1, & Bantam.
Hammer Mills & Pulverizers 3 to 50 HP.
Rotary Cutters 1½ to 5 HP. & up.
Spr. Waldron Stainless spike crusher.
Pebble, Jar & Ball Mills, Lab. to 6' x 8'.
3 Roll, 9" x 32", 12" x 30", 16" x 40".
Lehman 4 Roll W.C. 12' x 36" Steel.
Colloid Mills 1½ H.P. & up.
Mixers: Baker Perkins jack. 100 gals.
Baker-Perk 15 HP. Masticator Mixer.
Day Imperial 75 & 150 gals.
Change Can Mixers 8, 15, 40 gals.
Sprout-Wald. 10,000# horiz. Spiral Mixer
Day Jumbo 700 gal. horiz. mixer.
Blystone 3000# horiz. spiral mixer.
Day 1000# Ribbon Mixer & other sizes.
Lancaster 6' dia. 25 HP. & # 1, 3 HP.
Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP. Centrifugal 250 PSI.
Sifters: Day, Robinson, Rotex type.
Tablet Machines: Stokes Rotary RD3
Colton 4½T & other sizes.
Hydr. Presses, Plastic & Rubber Machy.
Partial Listings. Write for Bulletins

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107-8th St., Brooklyn 15, N. Y. Sterling 8-1944

CIRCLE U ON READER SERVICE CARD

FOR SALE

4—Type 302 Stainless Steel vessels 24" O.D. x 28' long overall, conical ends, 0.2" wall, 100# working pressure.

4—Shells, only, suitable for rectifying columns, etc., 23⅜" I.D., 24' long, 0.2" wall, type 302 stainless.

ARTISAN METAL PRODUCTS INC.
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TWinbrook 3-6800

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FOR SALE

Reaction kettles
Synthetic Resin Units

1—18,000 lb. charge stainless with agitator coils, condensers, etc. including new "Selas" gas heating unit. 1—18,000 lb. charge stainless with agitator coils, condensers, etc. heated by a "Trent" electric jacket.

1—10,000 lb. charge stainless with agitator coils, condensers, receiver etc. jacketed for "Arochlor" electric heater. All kettles in equal to new condition and being replaced by larger units by new resin manufacturer.

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FS-4920, Chemical Engineering
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WE PAY TOP DOLLAR FOR IDLE MACHINERY

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FOR SALE

BAKER PERKINS MIXER

"Unidor" Type-Size 14 DUM
Working Capacity—5 Cu. Ft.

GLOBE TRADING COMPANY
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CIRCLE Y ON READER SERVICE CARD

50,000 TOWER PACKING RINGS CERAMIC

Single spiral with corrugated outer surface 3¼" O.D., 3" L, 5/16" wall thickness.
Price way below cost

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INdependence 1-4100

CIRCLE CC ON READER SERVICE CARD

2—100 H.P. Carrier Brine Chilling Units
3—Niagara #633 No frost Spray Coolers
2—60 H.P. G.E. Motors with Automatic reduced Voltage Controls
100 H.P. D.C. Motor, 230 Vts & Controls

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A & Venango Sts., Phila., 34, Pa.
GArfield 6-2221

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2—Davenport 8' x 60' rotary dryers, 7/16" welded shell, complete

1—Louisville 7' x 70' rotary cooler, ½" welded shell, 1952, complete

1—Patterson 6' x 10' pebble mill, porcelain, jacketed

1—Buflovak 700 sq. ft. T304 SS single effect forced circulation evaporator, complete, with pumps, etc. Like new!

1—Buflovak 5' x 30' T316 SS rotary vacuum dryer, complete, late model, ASME

2—Buflovak vacuum shelf dryers: 110, 98 sq. ft.

STAINLESS STEEL TANKS

1—17,650 gal. horiz., T316 SS, 9' x 35', 40# WP
1—3700 gal. vert., T304 SS, 6' x 17', VAC.
1—3300 gal. vert., T304 SS, 6' x 14'
3—2750 gal. vert., T316 SS, 7' x 8', 50# WP
1—2500 gal. vert., T316 SS, 7' x 7', 70# WP, Agit.
2—2300 gal. vert., T316 SS, 7' x 8', Agit.
4—2250 gal. vert., T316 SS, 7' x 6', 70# WP, Agit.
1—2100 gal. vert., T316 SS, 6' x 10', open top
1—1900 gal. vert., T316 SS, 6' x 8', VAC.
12—1750 gal. vert. hoppers, T304 SS

AMERICA'S LARGEST SELECTION OF ROTARY DRYERS & KILNS — 41 UNITS IN STOCK. SEND FOR ILLUSTRATED CIRCULAR #860A

MIXERS

60—200 gal. Baker-Perkins, sigma, jkt.
1—150 gal. Baker-Perkins, sigma, jkt.
3—100 gal. Baker-Perkins, sigma, jkt., 25 HP
1—100 gal. Baker-Perkins #15-UUMM, disp. blades, 100 HP, jkt., comp. cover, motorized tilt.
1—100 gal. J. H. Day, sigma, T304 SS, 10 HP
3—75 gal. Day Imperial, dispersion
2—50 gal. W & P, sigma, jkt.
1—20 gal. Day, sigma, jkt.
1—425 cu. ft. st. st. ribbon
1—Patterson 6' dia Dbl. cone blender, 69 cu. ft.
1—Sturtevant #9, 150 cu. ft. rot. blender, UNUSED
1—Worthington 70 cu. ft. rotary blender
1—Robinson 2 cu. ft. conical blender, st. st.
1—Mueller T316 SS contin. mixer

CENTRIFUGALS—FILTERS

3—Sharples #C-27 T316 SS Super-D-Hydrators
2—Sharples #C-20 T316 SS Super-D-Hydrators
30—Sharples #AS-16V Inconel Super Centrif.
1—Bird 32" x 50", T316 SS
2—Bird 24" x 24" type CH monel, horiz.
1—Tolhurst 48" dia. susp., T304 SS perf.
6—A.T.&M. 40" dia. susp., T304 SS, 40 HP
1—Bird 40" dia. susp., steel, imperf.
1—Tolhurst 26" dia., susp., steel, perf.
1—A.T.&M. 12" dia., susp., T304 SS perf.
1—Oliver 5'3" x 8' rotary vac. filter, UNUSED
2—Oliver 5'3" x 3' rotary vac., T316 SS, ASME
1—Niagara #510-28, 510 sq. ft., T316 SS filter
1—Niagara #53-36, 53 sq. ft., T304 SS filter
2—Sperry 30" "NI-RESIST" P. & F. filter presses

CLOSE OUT!
CHEMICAL PLANT—ORANGE, TEXAS

2—Buffalo type R blowers, T316 SS, 2330 cfm
1—Struthers Wells 3500 gal. T316 SS jkt. reactor
2—Vulcan 96" dia. T316 SS bubble cap columns
1—Vulcan 72" dia. copper bubble cap column
2—Sharples C-20 T316 SS Super-D-Hydrators
1—17,650 gal. T316 SS horiz. tank, 9' x 36'
1—Struthers Wells 630 sq. ft. T316 SS evap.
5—800 sq. ft. T316 SS heat exchangers
2—1450 sq. ft. T316 SS heat exchangers
3—Worthington 160 ton steam-jet vac. refrig. units

MANY MORE ITEMS
SEND FOR ILLUSTRATED CIR. #1259A

PERRY EQUIPMENT CORPORATION

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Ten Million Dollar Chemical Plant

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Type 316 Stainless Steel Equipment

7—Alloy Fabricators Type 316 SS pressure vessels, 4500 gal., complete with agitators and drives, 45 psi.

2—Alloy Fabricators Type 316 SS, 4500 gal., jacketed reactors, complete with agitators and drives.
2—Alloy Fabricators Type 316 SS, 1000 gal., jacketed kettles, ⅜" material throughout.
12—Whitlock Type 316 SS pressure vessels with coils, 270 gals.
3—Whitlock Type 347 SS pressure vessels with coils, 300 gals.
3—Type 316 SS mixing tanks, 6000 gal., complete with agitators and drives.
8—Acme Type 347 SS settling tanks with cone bottoms, 1000 gal.
1—2800 gals. Type 316 SS vertical vacuum receiver.

3—Vertical Type 316 SS activated carbon absorbers, 5'4" dia. x 16'.

1—Struthers Wells 75 gal. Type 316 SS 500 lb. pressure vessel ASME code National Board.
2—Project fabricators type 316 SS vacuum receivers, 160 gals.
2—Pfaudler 500 gal., glass lined jacketed kettles.
1—Pfaudler 20 gal., glass lined vacuum receiver.
1—Haveg, 500 gal., vacuum receiver.
2—Aluminum horiz. 5000 gal. storage tanks.
5—Pfaudler horiz. glass lined storage tanks, 5000 gals.
1—Pfaudler vertical glass lined storage tank, 5000 gals.

4—Rubber lined horiz. storage tanks, 5000 gals., working pressure 45 lbs.
16—Rubber lined vertical storage tanks, 4500 gals., working pressure 45 lbs.

2—Rubber lined vertical storage tanks 2500 gals, working pressure 45 lbs.

11—Patterson-Kelley type 316 SS condensers, 75, 84 and 235 sq. ft.
4—Type 316 SS packed columns, 18" x 11'7⅛", working pressure 45 psi
2—Shriver 18" x 18" SS plate and frame filter presses, 10 chambers.
5—Shriver 42" x 42" wood plate and frame filter presses, complete with hydraulic closing device, 30 chambers.

7—Buflovak Type 316 SS jacketed rotary vacuum dryers, 5'x30', complete with 25 H.P. explosion proof motors and drives

3—Type 316 SS Ter-Meer continuous type centrifuges 4' dia. bowls complete with motors.
3—Readco stainless steel horizontal blenders, 450 cu. ft. working capacity, complete with 75 HP motors
3—Mikro model 3 TH stainless steel pulverizer, complete with 40 HP explosion proof motors
1—Mikro SS bantam pulverizer, model CF, complete with ¾ HP explosion proof motor.
3—Gruendler SS, lab size, pulverizers.
3—Nash, Model TS-12, vacuum pumps, with motors.
1—Stokes Type 316 SS, jacketed, rotary vacuum dryer, 2' x 3'.
14—Copper jacketed mixing kettles, 3500 gal. each.
14—Copper jacketed rotary vacuum dryers, 8 x 10.
5—American type 316 SS blower model MD, size 27".
1—Fuller Type 316 SS, airveying system.
1—Aldrich Groff type 316 SS hydraulic triplex pumps, size 2¾" x 4" at 500 PSI.
1—Quimby type 316 SS twin screw pump with 10 hp variable speed drive.
100—Stainless steel centrifugal pumps, all makes and sizes.
2—Powell type 316 10" hydraulically operated flanged and gate valves.
2—Tyler type 38 tandem SS Hum—mer screens, size 42" x 9'8".
3—Williams type 316 SS hammer mills with 100 HP motors.
3—150 gals. type 316 SS jacketed kettles.
3—200 gals. type 316 SS jacketed kettles.
12—Type 316 SS cyclone separators, 5'2" x 10'8" overall.
500 Tons of type 316 stainless steel pipe, fittings, and valves, ranging from 2" to 6".
500 Tons of structural steel.
50—Stainless steel and aluminum hoppers, all sizes.

R. GELB & SONS, INC. 75 ANNIVERSARY

U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900

CIRCLE AA ON READER SERVICE CARD

WHY BEND BACKWARDS!
start out RIGHT with
GELB
CHEMICAL PROCESS EQUIPMENT

1—Williams 4 roll Comet size mill, complete with all auxiliary equipment
1—General American 7' x 40' rotary dryer, ⅜" welded shell, complete
1—Sharples type 316 SS Super-D-Canter, Model PN-14.
1—AT&M type 316 SS suspended type centrifuge complete with 26" perforate basket, plow and motor

AUTOCLAVES, KETTLES AND REACTORS

2—Monel 2500 gal. jacketed autoclaves, 175# jacket, 175# internal pressure
1—Pfaudler 200 gal. glass lined jacketed reactor, complete with anchor type agitator and drive
1—Struthers Wells type 316 SS jacketed reactor, 2000 gal., complete with agitator and drive
1—Van Alst 250 gal. SS jacketed kettle, complete with SS column and condenser
2—Blaw-Knox 600 gal. steel reactors, complete with double motion agitators and drives, 50# jacket, 50# internal
1—18,000 gal. aluminum storage tank

DRYERS

2—American double drum dryers, 42" x 120", ASME N. B., complete with drives and motors
1—Hersey stainless steel rotary dryer, 3' x 16'
1—Allis Chalmers SS 6' x 50' rotary dryer, complete
10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
3—Link Belt steel roto louvre dryers, Model 207-10, 310-16, 604-20
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
2—Louisville rotary dryers, 8' x 50', stainless steel
1—Buflovak SS jacketed rotary vacuum dryers, 3' x 15'
3—Buflovak steel jacketed rotary dryers, 3' x 15', 5' x 20', 5' x 35'
1—Traylor 4' x 40' rotary dryer
1—Western Precipitation Corp. S.S. pilot plant spray dryer, Type N-2
1—Bowen SS pilot plant spray dryer

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
12—Sweetland #12 filters with 72 SS leaves
1—Niagara SS filter, Model 510-28
1—Oliver type 316 SS rotary vacuum filter, 4' x 5'
1—Oliver horizontal filter, 3'
1—GATX SS pilot plant filter, 2' x 6"
10—Shriver plate and frame filter presses, 12" x 42"
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers

CENTRIFUGES

7—Western States 40" type 316 SS suspended type centrifuges complete with perforated baskets, plows and 40 HP motors. Year built 1953
1—AT&M 48" SS suspended type centrifuge, complete with plow, motor and imperforate basket
1—Fletcher 48" center slung SS centrifuge, complete with perforate basket and motor

THE GELB GIRL—SEPTEMBER 1960

4—Tolhurst 40" center slung rubber covered centrifuges, with perforate baskets and motors
2—Fletcher 40" center slung rubber covered centrifuges with perforate baskets and motors

MIXERS

1—Cleveland SS double cone blender, 85 cu. ft. complete with drive and motor
2—Sturtevant #7 dustite rotary batch blenders, NEW
15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Baker Perkins Size 20, 2000 gal. double arm jacketed vacuum mixer with double naben blades
1—Baker Perkins Size 16, Type UUEM, 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor
2—Baker Perkins 20 gal. SS. jacket vacuum double arm mixers
1—Baker Perkins Size 4, laboratory mixer, sigma blades, 1 gal. total capacity
1—Banbury #1 mixer, chrome plate rotors, with 50 HP motor
1—Stokes SS granulating mixer, Model 21 J

MISCELLANEOUS

1—Vulcan SS bubble cap column, 4' x 25 plates
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Struthers Wells type 316 SS heat exchanger, 330 sqft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 and 600 sq. ft.
1—Downington type 316 SS heat exchanger, 750 sq. ft.
2—Swenson type 316 SS vacuum crystallizer, 3'6"x12', 2'x12'
3—Williams type 316 SS hammermills, Model AK
1—Sprout Waldron Model 501-D pelleter
1—Ross 6" x 14", 3 roll paint mill, complete
1—Stokes #412F vacuum pump, complete

2—2000 gal. type 304 SS vertical storage tanks
1—Richmond Engineering type 316 SS 40 cu. ft. horizontal double ribbon blender
1—Oliver stainless steel rotary pressure precoat filter, 5'3" x 8'
4—Davis Engineering Carpenter 20 heat exchangers, 125 sq. ft., NEW

R. GELB & SONS, INC.
U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900
75 ANNIVERSARY

CIRCLE BB ON READER SERVICE CARD

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MALT · RESINS · SALT · STARCH · POWDERS · FEEDS · PLA
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FLO-TRONICS®

fluidization can do it

... more economically and efficiently! Since their introduction, more and more firms using powdered or granular materials are realizing tremendous savings with Flo-Tronics Fluidization air conveyance systems. They eliminate the cost of individual containers, vastly reduce costs of hand labor, free space and working capital, and provide complete sanitation.

Typical savings (on an investment of $24,000) realized by a paper mill handling bulk starch are illustrated in this table.

	2,000,000 lbs.	3,000,000 lbs.
Volume (one type of starch)		
Annual Savings		
(a) *Bulk Price Differential—$.27/cwt*	$5,400	$8,100
(b) *Unloading, handling & losses—$.15/cwt*	3,000	4,500
TOTAL SAVINGS	$8,400	$12,600
Annual Costs		
(a) *Depreciation (over 15 years)*	$1,600	$1,600
(b) *Taxes (1% of investment)*	240	240
(c) *Repairs & maintenance (4%)*	960	960
(d) *Operation (labor, power, etc.)*	380	550
TOTAL COSTS	$3,180	$3,350
Summary		
Annual savings before Federal Inc. Taxes	$5,220	$9,250
Return before Federal Inc. Taxes	21.8%	38.5%
Net savings after Fed. Inc. Taxes (at 52%)	$2,505	$4,440
Return after Federal Inc. Taxes	10.4%	18.5%
Pay out time (after deprec. & Fed. Taxes)	9.6 yrs.	5.4 yrs.

Whether you require a complete Fluidization system or merely system components, Flo-Tronics can custom-build to your specifications or requirements. For an engineering evaluation of your material handling requirements—or simply a discussion of your needs with your own engineers, write or call Mr. William P. Edmunds, Dept. 100,

FLO-TRONICS INC
1420 zarthan avenue
minneapolis 16, minn

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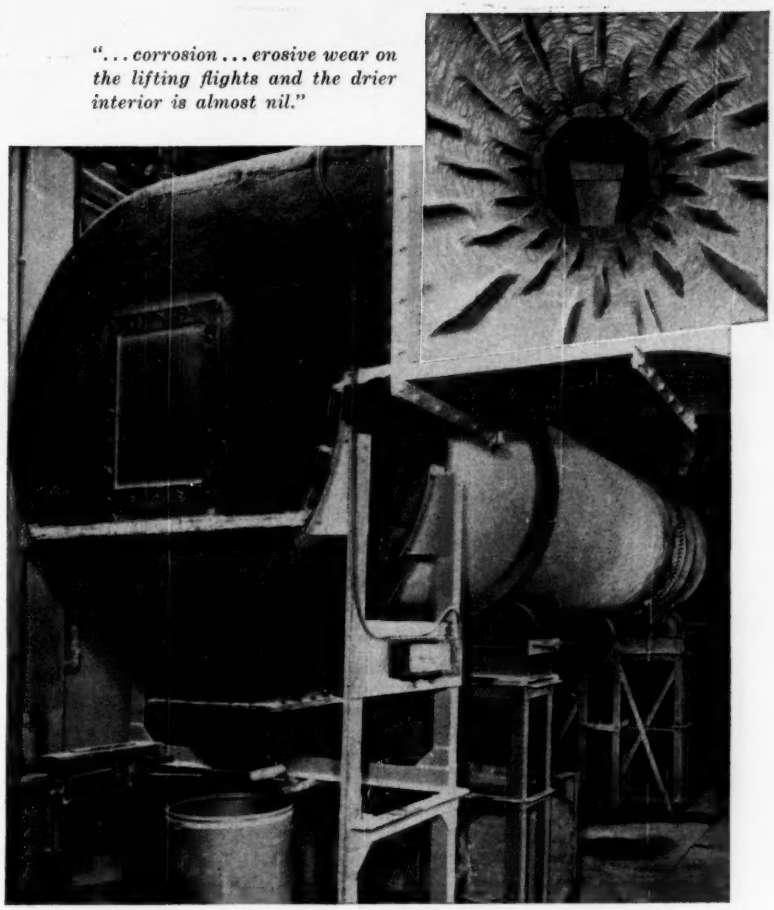
"...corrosion...erosive wear on the lifting flights and the drier interior is almost nil."



Dramatic New Application Proves DuVerre's Durability Under Punishing Corrosive Conditions

A novel solution to a severe corrosion problem in this continuous rotary drier was provided by du Verre resin bonded fiberglass construction. Wet HCL fumes resulted in extreme corrosion throughout the original alloy construction. Heat compounded the problem, with temperatures ranging from 225° F. to 290° F. It was vital to arrest corrosion to absolutely prevent product contamination.

As a test, a portion of the actual drier was fabricated by du Verre. The results were so conclusive that du Verre supplied a complete new drier, including the exit gas separator housing, gas entrance and product discharge housing and lifting flights. Today, after a year's service, the entire du Verre drier unit remains completely free of corrosion. In addition, erosive wear on the lifting flights and the drier interior is almost nil.

Light weight, du Verre is easy and inexpensive to install. Since du Verre is homogeneous (not a coating), it requires no painting or other maintenance. du Verre is entirely self-supporting; its structural rigidity does not depend on external reinforcing.

Investigate the many advantages of du Verre construction for ducts, stacks, hoods, tanks, trays and special units.

du Verre inc.

Write Today for Bulletin 101!

du Verre...First in Quality for Complete Corrosion Control with Reinforced Plastics.

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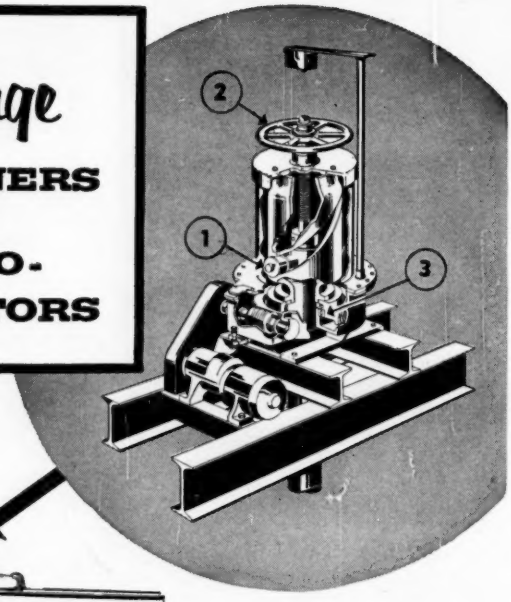
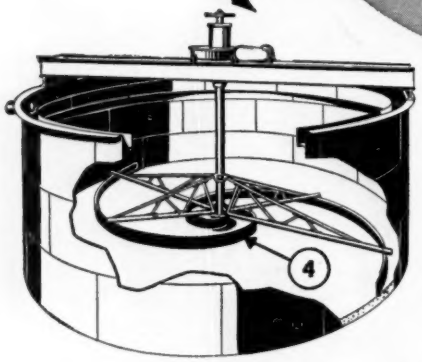
Hardinge

THICKENERS and HYDRO-SEPARATORS





1. "Auto-Raise" device.
2. Manual or power raise.
3. Replaceable ring-type ball bearing support.
4. Spiral rakes, and "froth rings."

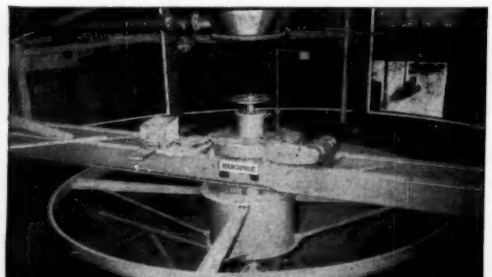
The higher the solids content in the thickener underflow, the lower the cost of filtering for subsequent processing or disposal.

The spiral rakes of the Hardinge Thickener compress the solids to maintain high density of underflow.

The "Auto-Raise" drive mechanism prevents overloading as the underflow is thickened.

Submerged parts may be supplied with rubber or lead covering or fabricated from wood or any metal available for structural parts.

Complete specifications upon request. Bulletin 31-D-11.



Also available are "froth rings" for froth-free overflow and superposed type tank construction (as shown above) for minimum floor space and building economy.

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NEW STRAHMAN SAMPLING VALVE CANNOT CLOG

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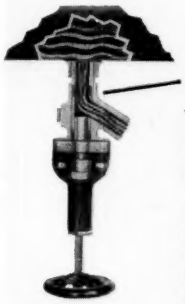

2. In open position piston retracts, leaving entire body empty for FREE-FLOWING LIVE SAMPLE.

Perfect sealing is assured by two compressible, replaceable Teflon rings.

These Sampling Valves are designed for simple installation in existing systems, merely by welding a ¾" half coupling into the pipe or vessel, from which samples are required.

PD-794

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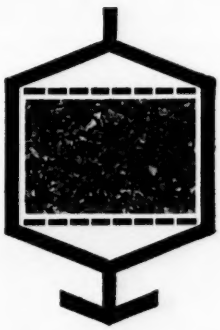
how to make dew

Do you make do with water laden with chlorine and organic decay or discoloration when fresh morning dew will do better? Make dew do for you too with water purified by activated charcoal. Chemical, pharmaceutical and food producers have been doing it for years. It's a sure bet for product improvement.

activated carbon



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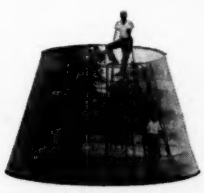
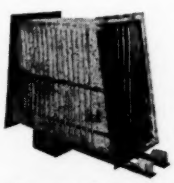


A large alloy mesh fabrication



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Remember, the rental cost is applicable against the price of the machine.

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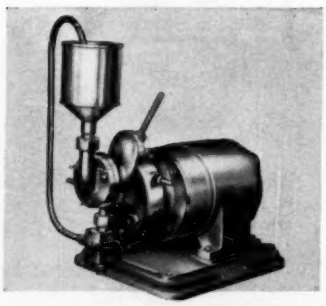

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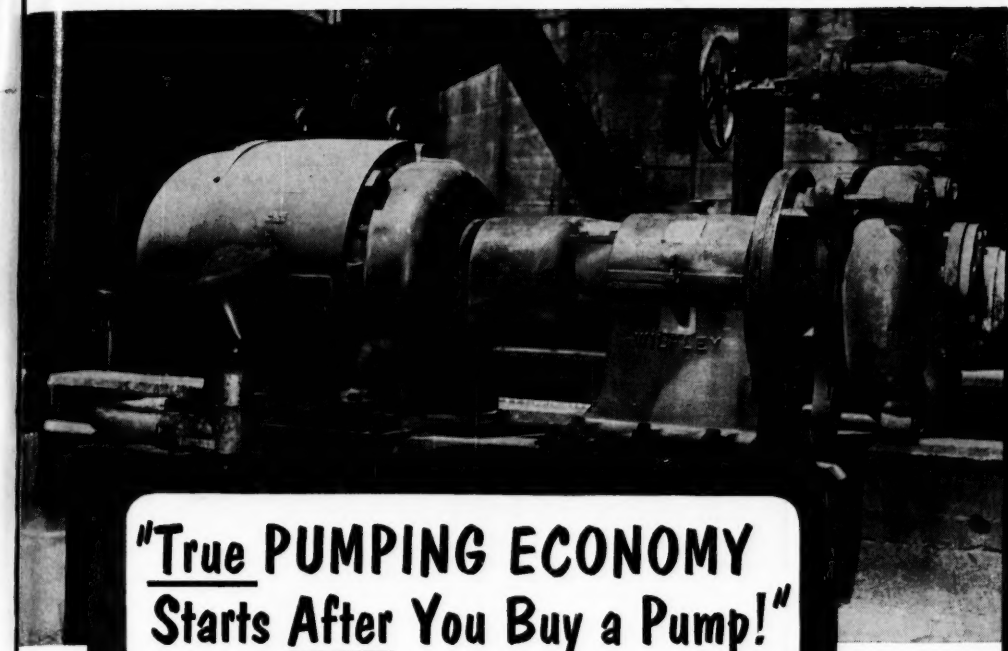

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50 horses kick up a flurry in this slurry

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He's referring to two 50-hp turbine-type LIGHTNIN Mixers that equalize this much slurry in two big surge tanks at Corn Products Company's sprawling Argo, Ill., plant.

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Operating 24 hours a day, seven days a week, the two LIGHTNIN Mixers require only a routine once-a-week maintenance check. Assistant Plant Engineer Peterson doesn't worry about parts replacement: all mixer components are standard and quickly available. Many other LIGHTNIN Mixers of all sizes and types are in use throughout the plant.

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OPERATOR Bob Piper checks mixing pattern generated by one of the two LIGHTNIN Mixers, in background.

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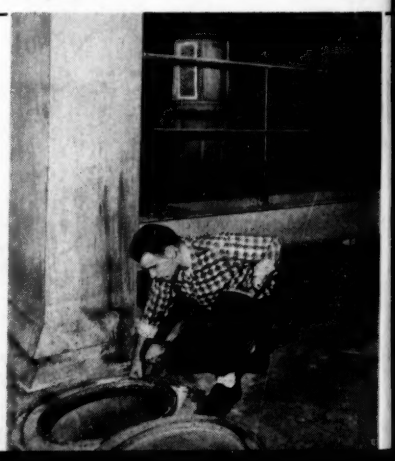
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